THE GLASS INDUSTRY
THE JOURNAL OF GLASS MANUFACTURING

Fifth International Glass Congress

Munich, Germany, was the rendezvous of 800 participants, glass men and their families from 35 countries at the record breaking 5th International Congress on Glass from June 29 to July 4, 1959. This was the largest congregation of glass people that has met at any time, anywhere. An excellently arranged scientific and practical fare was presented by a very kind hospitality with much beauty for ear, eye and mind. Records were also broken for overseas attendance, numbers of countries represented, and "non-Western" participation.

Lillie in Professor Turner's Chair

Glass congresses are one of the products of the International Commission on Glass in which now 14 major glass-making countries are represented through the delegates of their glass or ceramic societies or institutes.

At the annual meeting of the Commission which took place after the Congress closed, America was honored by the election of Howard Lillie, of the Corning Glass Works, Corning, New York, as its third President.

He succeeds Dr. B. Dudding, England, who had followed Dr. W. E. S. Turner, founder of the commission, and bearded father of modern glass science, professor emeritus of glass technology of the University of Sheffield.

Howard Lillie, staff research manager, research and development division, Corning Glass Works, who was elected third president of the International Commission on Glass.

Invitation to Washington

Applause resounding with sincere appreciation and the satisfaction of an expectation finally fulfilled greeted the announcement of Oscar Burch, Owens-Illinois Glass Co., Toledo, O., and the president of the American Ceramic Society, which contained the brief invitation to the Congress to meet in Washington, D. C., in 1962.

The Congress convenes every three years unless—as has happened for a considerable period of time—the conduct, preparation or consequence of war precludes its convocation. Congresses thus have been held in Milano (1933), London (1936), Venice (1953), Paris (1956) and Munich (1959).

In writing this article, the author has selected highlights of the Congress. Later on, the entire material presented at Munich during the Fifth Congress will be published as a special volume by Glastechnische Berichte.

Herr von Buelow, president of the Congress (left), who presided over the International meeting, and Dr. Ludwig Erhard, Common Market Minister, delivering his formal address.

In Practice

The organizers of the Congress wanted to approach an ideal in which:

(1) The talks were limited to about 35 in number, so that no parallel sessions would be held, and all talks would be geared to all people on a generalist, rather than a specialist, level.

(2) A balance was to be struck between practice and science.

(3) All papers were preprinted, so that a full 15 minutes of discussion could follow each brief presentation of 15 minutes.

For this reason small quota on few topics were given to the national organization. It was a great success to have prints of all papers in our hands ahead of the meeting, and to have centrally controlled red and green lights, as well as clocks, monitor the speakers efficiently. As a result of this drive for an ideal, it was possible to limit the Congress to 50 papers in 7 sessions, of which 3 were "practical."

Quality Control

The topic of the first session. The principles of proportional, integral and combined *automatic control* were analyzed by the Philips Laboratories[1], applications were reviewed critically. A Belgian survey[2] of applications of *statistical techniques* to the control of flat glass, including parameters such as bubble count, density, viscosity, light transmission and analytical composition, was based on numerous practical examples.

It was remarked that control charts should be inscribed with personal observations by foremen and operators regarding qualitative changes not included in control parameters. This is in long-overdue recognition of the chief limitation of all automatic controls; namely, the latent existence of many important variables not included in the system, always selected for relative simplicity as much as for relevance.

Human and psychological skills were also stressed. The needs for the mastery of contributing variables *before* surrender to automatic control was underlined repeatedly.

The HILGER *recording spectrograph* was used in silicate analysis by Pilkington's Laboratories who were able to make determinations of minor components with a variation of only 2 per cent[3]. During the further discussion of spectrography it was pointed out in passing that, notwithstanding certain advantages, *X-ray fluorescence analysis* of glass still lacks this precision.[4] America, through J. POOLE[5], contributed a survey of the use of *fluorescence* in control problems; Russia[6], a complete table of *identification of defects* (stones and cords).

Molds

The second session, on *melting and forming* glass brought three papers on seldom-published experiences on the temperature control of molds. In Owens operations, fill time viscosity was given as 2.7-3.8 in Miller press and blow as 3.7-4.1[7]. The maximum surface temperature where no deformation was observed was given as 7.1-7.7 for Owens (up to 8.8 for thick sections ; 6.1-7.1 for Miller[7]. Giegerich's well known German studies were followed by other German workers[8, 9].

Control Instruments

A technical viscometer for immersion in the melt[10] and a bolometer, combined with filters for a novel scheme of evaluation of radiation from the melt[11] were described. Philips people tried to rationalize quantitatively the investment in instruments in glass production, arriving, for certain specifications of accuracy at 1 per cent of production cost (including amortization)[12]. It was found that a small excess in accuracy can quickly double or quadruple this cost percentage.

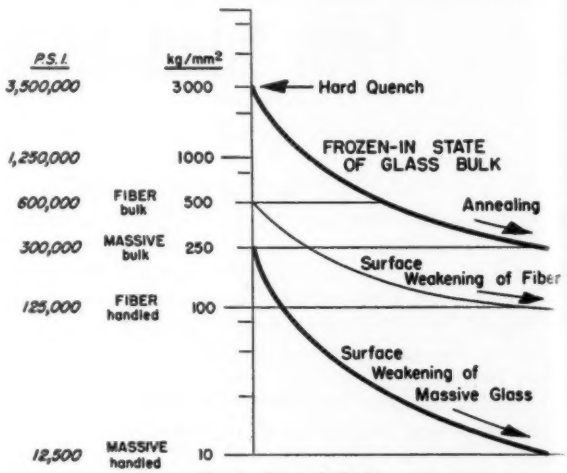

Fig. 1. Strength Scale

Mechanical Strength

At the beginning of Session III, which dealt with mechanical strength, the Congress was shown a table prepared by Philips engineers[13] in which our experience so far was summarized as follows (approximate conversions to psi by reviewer):

Theoretical	3,500,000
1 micron fiber max.	1,250,000
Fiber glass	20,000-1,250,000
Bulk glass	250,000
Glass product	6,000-18,000
Reshaped glass	2,500-12,000

If, as is reasonable,

(1) freezing in of high temperature conditions (ANDERSON, OTTO, BARTENEV)

(2) surface weakening (GRIFFITH, GREENE, SHAND) are taken into consideration the strength scale of Fig. 1 (rearranged by reviewer) can be put together:

Schardin[14] reported, as could be expected interesting test methods and results. Bending strength was evaluated:

(a) by breaking circular plates (not, as most frequently done, strips), in which case fracture occurs in or near the center, so that the rim effect is reduced, and
(b) by inference from the module, which was determined by the original method of optically projecting increasing areas of a grit as a plate is bent. Details of this method were published in 1955 (15).

Among his results should be reported here:

(a) The increase by almost 100 per cent of bending strength when the loading speed was increased by a factor of 150.
(b) The decrease of strength by 65 per cent on sandblasting the tension side, and, less obviously, by 88 per cent on sandblasting the compression side; and the low scatter of values in the former case (with which we are familiar in the U.S.A. where we often sandblast small number tests realizing that we decrease average strength gaining reproducibility).
(c) No increase in strength on siliconing.
(d) Details on breaking laminated plates.

Cinematrographic records and their interpretation were presented. There is enough energy for the fracture to penetrate the compression layer for a little stretch, then it slows up or stops, partly under the influence of the transversal wave reflected from the opposite face.

We were convinced of the importance, to the practician, of understanding of the process of fracture for those interested in the chances of preservation of an object rather than in safe limits of calculated strength.

Dr. Norbert J. Kreidl, Bausch & Lomb Optical Co. (left), and Professor Charles H. Greene (Alfred University) and charming daughter, Meg, exploring Wieskirche, gem church of German rokoko.

B. LONG'S[16] presentation of the cleaving of plates into half foils, thinner than 5 mm., whose complementary profiles allow lamination without finishing, fascinated the audience. Details are disclosed in a patent[17].

We are more conversant in the U.S.A. with MOULD'S work[18] and his concepts on fatigue which were supplemented by new evidence and reasoning in Munich. Fatigue is produced in glass by the slow growth of surface cracks involving interaction of surface and a chemical medium like water vapor. Fatigue is reduced or eliminated by chilling or drying.

These results can be fitted nicely in the Philips strength scale (Fig. 1).

The session was concluded with the presentation of SMYTH'S theory of viscoelasticity[19]. A side result of this theory is his explanation—by the greater randomization of defects at very high temperatures—of the observation that glass chilled from very high temperatures has no birefringence.

Tank Currents

One of the subtopics of session IV. Japan described a model tank filled with 85 per cent glycerol, with a colored oil tracer, allowing to improve earlier equations of PEYCHES[20]. St. Gobain also reported model work leading to numerical correlations between model and practice[21]. Belgian research introduced the mathematical tool of dimensional analysis[22].

Refractories

The other subtopic of Session IV, was specifically concerned with:

(1) How the vitreous phase affects the texture of electrocast blocks and contributes to the pattern of corrosion[23].
(2) How to study refractory structures by reflected light microscopy[24], and
(3) The possibilities of basic bricks in regenerators[24].

Physical and Chemistry of Glass

Work in this session (V) is not always separable from that on structure (VI) and is, in part, reported there.

A new device for measuring heat content showed off heat effects above the transformation region[25].

A bearing on glass making had studies presented on the way SiO_2 behaves in a sodium borate melt, where it reacted with the borate that was formed much more than with the carbonate of the original batch[26]; and on the solution of bubbles in melts, in which it appeared that the greater rate of solution of bubbles at high temperatures affected fining more advantageously than the loss at these high temperatures of oxygen by the transition elements like As used as finers[27].

European listeners heard, often for the first time, an extensive description of the nucleation processes underlying the development of ceramics from shaped glass such as pyroceramics[28]. For instance, TiO_2 was identified as the catalyst in the case of the field $2\ MgO \cdot 2\ Al_2O_3 \cdot 5\ SiO_2$.

Dr. Atma Ram, director, Glass & Ceramic Institute, Calcutta, and Dr. W. A. Weyl, chairman, division of Mineral Technology, Pennsylvania State University.

The Structure of Glass

A great variety of topics and opinion, in this area (session VI) caused lack of time, occasionally, for all people who wanted to continue the argument to proceed, and some material was also presented in session V, but is reviewed here.

The controversy on the structure of borate glasses continues and remains unsettled. The Norwegian school[29] is still convinced that the change of properties observed at a certain level of alkali additions to B_2O_3 can not be explained by WARREN'S concept of a coordination change from 3 to 4. KROGH-MOE believes that alkali borate glasses have a complex, somewhat ordered structure and offers crystalline anhydrous potassium pentaborate as a comparison model.

In its basic structure, rings of triangles are arranged in alternating planes around a 4-coordinated B. There is some similarity to T. ABE'S concept which postulates certain regularities of 3 and 4 coordinated boron oxygen patterns but retains the 3 to 4 coordination change picture which still found majority support in the discussion. However, to this reviewer the closing passages of KROGH-MOE'S paper do no longer seem to negate this possibility altogether, only to deny its dominant role in the property changes.

Russia's APPEN[30] showed conclusively how first aluminum, then boron, changes coordination (6 to 4, and 3 to 4 respectively) in alkali alumoborate glasses, and he gave quantitative rules for these changes. His, and STEVELS', findings appear to preclude at this time the wholehearted acceptance of the Norwegian picture.

STEVELS, of Philips, Holland, and his co-workers[31] showed on numerous examples that glasses containing less than a certain fraction of network formers vary in certain properties related to short range order (e.g. dielectic loss, mechanical loss, viscosity, expansivity) just in the reverse direction as conventional glasses. They felt compelled to coin the term "*invert glasses*" for these high modifier glasses.

Three American contributions can be summarized very briefly since their contents are more familiar here. A. J. COHEN[32] interpreted the absorption bands of radiation-treated pure and doped silica glass by definite assignments which are generally supported, with some exceptions being taken by the Dutch school. BESTUL, from the National Bureau of Standards[33], who comes from the field of physical chemistry of organic compounds, reported on findings which gain increasing attention from theoretical people in the inorganic field. Briefly, they attempt to relate the progress of transformation in a glass to universal relaxation facts independent of composition, so uniting very different areas of conventional glasses and plastics in one important behavior. And WEYL[34], in a comprehensive survey, gave European audiences insight into the penetrating effects of surface disarrangements of ions ("depth action") upon apparent bulk phenomena such as mechanical stress patterns.

Left to right, Dr. Kreidl; Dr. J. Stanke, Czechoslovakia; Mrs. Kreidl; and Dr. M. Volf, Czechoslovakia.

Although given in session V, mention should be made here of the indication that noted British scientists[35] join the increasing number of people stressing some inadequacies of the limitations of the random network concepts. At least in phosphates they find evidence of measurable, often small, (P_4O_{10}) chain lengths, the chains sometimes held together by M^{2+} ions. This explains why additions of alleged modifiers may fortify the structure of phosphate glasses by increasing this hold.

Infrared

The last (7th) session collected publications on infrared transmission of glasses and radiation phenomena in the melt.

The transmission of glass at higher temperature can now be calculated from equations showing the shift of the equilibrium in *water bands* as a function of temperature and from tables showing these bands for various types of glass, according to Dr. SCHOLZE, of the Planck Institute[36]. The 2.7-2.9 bands were assigned to free OH groups, the 3.3-3.9 (and 4.25) bands to OH groups bonded to the network neighbor by what is more or less a hydrogen bond.

The "water bands" are, of course, only some of the bands affecting the entire range from 1 to 20 microns which has become a desired range of transmission in the past few years. Dr. H. BLAU, of Ohio State, discussed the *fundamental relations* governing infrared absorption as a function of vibrations between masses of constituent ions bonded by given force constants, and derived principles of selection of practical glasses from these relations.

In oxide glasses, cations must be large (Pb, As, Sb, Te, V), or the force constant low (CaO-Al_2O_3 field). Otherwise, O must be replaced by higher mass anions (S, Se) preferably with a high mass cation, too, (As, Sb), e.g. As_2S_3 glass[37]. KREIDL described some practical examples[38].

A very thorough analysis of infrared absorption spectra with *assignments to vibration modes* was given by ADAMS and DOUGLAS from Sheffield[39]. On the water band they agree essentially with SCHOLZE[36]. The analysis of borates substantiates the classical picture of coordination changes. From the spectra of alumoborates the formation of AlO_4 can be inferred in agreement with APPEN[30]. A surprising assignment was made of the bands in tellurate glasses, namely to modes of vibration of *six-coordinated tellurium.*

The discussion of the displacement of SiO_2 absorption bands to longer wavelength in high PbO glasses, and

(*Continued on page* 505)

High Temperature Alloys for the Glass Industry

Author's Note: A great many of the specific uses developed for these new alloys in the glass industry were sponsored by individual companies and must be held confidential until released. All actual data described in detail has been released for publication by the sponsoring companies.

by Bruce F. Richardson
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Part Two: Applications

TWO KINDS OF METALS and alloys are used in the glass industry. The first kind includes the high-conductivity metals, such as the cast irons and copper-base alloys. The second type includes high-temperature metals.

The high-conductivity metals and alloys are very useful in glass manufacture because they are able to carry heat rapidly to a fluid or gaseous coolant. These metals generally have fairly low melting points, but, because of their heat-carrying capacity, they are able to remain solid even though they come in contact with glass at a temperature somewhat higher than the melting point of the metal. These metals and alloys cannot be strictly classed as high-temperature alloys; they will not be mentioned again.

High-temperature metals, on the other hand, which we are dealing with here, are for continuous operation of elevated temperatures (900°C. and higher) with or without imposed stresses.

The Viscotherm alloys, for example, may be used at temperatures up to 1300°C. over extended periods of time in gathering, feeding and forming operations. Some of the requirements for high-temperature metals and alloys used in and around the glass house are:

Properties Essential to High-Temperature Operation

1. Metals and alloys must be refractory; they must not melt either on the surface or incipiently when exposed to elevated temperatures.
2. They must be geometrically stable at elevated temperatures; their creep rate must be low, and growth should be negligible. Thermal expansion should be a smooth, continuous function of temperature.
3. Metals and alloys, and their oxides, must not spall in the face of heat shock in such a way that small foreign particles mark the product.
4. Metals and alloys must have heat shock resistance so that continuous, severe hot-and-cold cycling does not cause cracking.

Properties Desirable for High-Temperature Operation

1. Metals and alloys should have high strength at elevated temperatures; ultimate specific strengths in the order of 5,000 to 10,000 psi in the 1000°C to 1250°C range are attractive.
2. They should be gas-free.

TYPICAL APPLICATIONS FOR VISCOTHERM ALLOYS IN GLASS MANUFACTURING

A. Gathering Operations	B. Feeding	C. Forming
1. Bushings	1. Orifices	1. Molds
2. Tips	2. Plungers	2. Plungers
3. Pins	3. Shears	3. Pins
4. Irons		4. Mandrels

Melting Point and Hot Strength

Molten glass temperatures are on the increase and have been advancing for at least fifteen years. Metals formerly considered widely useful in glass manufacturing operations will not serve with the more sophisticated formulations of today which are manufactured for such applications as physical and chemical apparatus, heat-resistant mechanical parts, certain electronic components, glass fibers and nuclear applications.

Almost all of the face-centered and body-centered cubic metals, as well as the continuous solid solution alloys presently in general use in and around the glass house, will maintain a practical level of hot strength up to a temperature which is equivalent to a factor of 0.4 of the melting point on the absolute scale. The melting

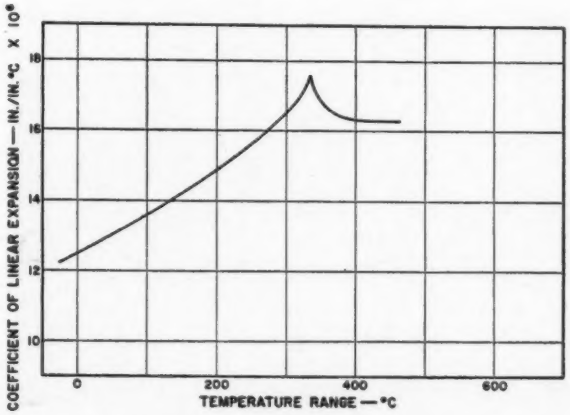


Fig. 1. Thermal coefficient of expansion curve for pure nickel. Note discontinuity in curve.

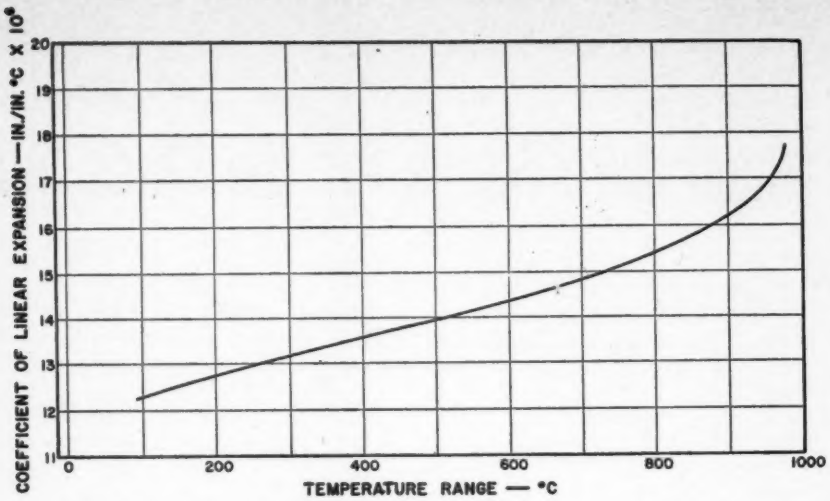


Fig. 3: Thermal expansion curve for Viscotherm 5. Note smooth continuity of curve.

point in degrees C and 0.4 absolute M.P. factor are shown in Table 1 for several useful pure metals and alloys.

Table I
MELTING POINT DATA FOR SOME USEFUL PURE METALS AND ALLOYS

Metal	Melting Point in Degrees Centigrade	Calculated Maximum Useful Temperature (0.4 of Absolute Melting Point) in Degrees Centigrade
Tungsten	3410	1202
Molybdenum	2610	882
Platinum	1774	547
Iron	1535	450
410 Stainless	1505	440
Nickel	1455	419
80 Ni 20 Cr	1395	396
316 Stainless	1395	396

Tungsten and molybdenum have good high 0.4 absolute M.P. hot strength. These two refractory metals, however, must be kept totally immersed in the molten glass at all times so that catastrophic oxidation will be avoided. Of all the pure metals and simple solid-solution alloys, platinum alone is the one refractory pure metal having a satisfactory 0.4 absolute M.P. factor and sufficient oxidation resistance to be used in air at elevated temperatures.

Fig. 2: Blow Iron Tip (Viscotherm 5) for use in gathering and blowing borosilicate glass at about 1500°C. This tip is 400°C, or colder, when it enters forehearth and therefore must resist heat shock. Tip has been in service for 20 months and shows no sign of heat shock checking.

In order, therefore, to build hot strength into the oxidation-resistant pure metals and solid-solution alloys, it has become necessary to employ other metallurgical means. This may be accomplished in a number of ways:

1. A martensite-type reaction.
2. The introduction of a second strengthening phase by diffusion; e.g., chromizing, nitriding, carburizing.
3. The precipitation of a strengthening phase from an unstable solid solution.

The Viscotherm family of alloys employs diffusion and precipitation in their strengthening mechanism.

An example of an application requiring a high-melting point material and considerable hot strength is shown in Fig. 2. This blow iron tip, made of Viscotherm 5, is for use in borosilicate glass at just under 1500°C. At this temperature of gathering, certain stresses are imposed which could cause a softer metal to bend. This part has been in use for about twenty months.

Thermal Stability

Metals and alloys useful to the glass industry will have a thermal expansion characteristic without any abrupt interruptions due to phase changes or other reasons. Fig. 1 represents a metal in which abrupt changes in thermal expansion do occur. This curve is for pure iron which, for other reasons, is not useful to glass manufacturers. Fig. 3 shows the thermal expansion for Viscotherm 5 which has the smooth continuity required by glass makers.

Figure 5 represents a glass tank nozzle, made of Viscotherm 1612, which must work in conjunction with a refractory. While this part remains at a fairly high temperature for long periods of time, it must not leak during the melting period, or, in other words, it must expand along with the neighboring brickwork.

Because this particular part must remain at high temperatures over a considerable period of time, it must also have a low creep rate at any given stress level. The stress (which at any given temperature brings about

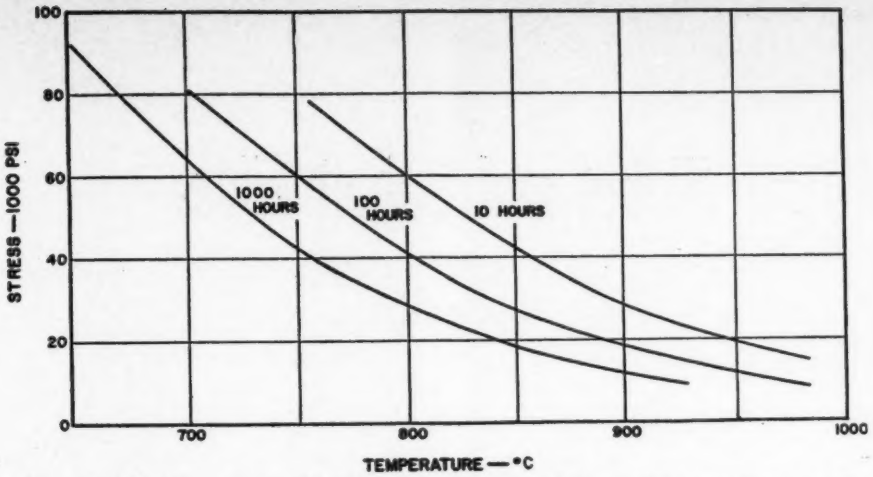


Fig. 4. Stress-to-rupture curves for Viscotherm 5 showing stress required at various temperatures to cause 2 per cent creep in 10, 100 and 1000 hours.

2 per cent creep in Viscotherm 5 in 10 hours, 100 hours, and 1,000 hours of continuous use) is shown in Fig. 4.

Growth is a little-understood and difficult-to-measure metallurgical phenomenon. A great deal of fundamental work is being done on the problem of growth at the present time without, as yet, any practical implications. Growth is manifested, as the term implies, by enlargement in any dimension of a metal or alloy upon thermal cycling. Although it does not apply in this discussion, one of the worst offenders is pure uranium, which has a phenomenal growth characteristic.

Unfortunately, almost the only way to measure the growth of a pure metal or alloy in a given environment is to make the tool, or part, out of the material in question and give the piece a use test. The Viscotherm family of nickel-base alloys, during a period of over two years, seems to have been remarkably free from growth.

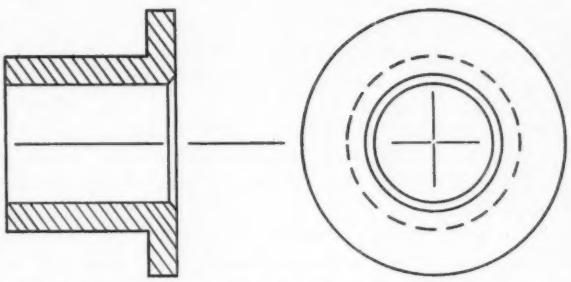


Fig. 5. Top and section views of a glass tank nozzle for bottom of forehearth used in a continuous metered feeding system. Viscotherm 1612 nozzle remained in service for entire period of campaign with no measurable deterioration.

Fig. 6: Knockout pin in Viscotherm 5 for use in high-temperature glass molding application.

Spalling, Flaking and Sloughing

Figure 6 shows a part, made from Viscotherm 5, which must resist oxide flaking, since any small particles leaving the pin would be picked up by the ware. A good, tight, adherent oxide layer having the same thermal expansion characteristics as the alloy itself is the best proof against these costly failings.

Heat Shock

Referring back to Fig. 2, this blow tip is one of a set used in rotation. It is almost black cold when it re-enters the gathering forehearth several rounds per shift—an outstanding example of heat shock punishment. No heat shock cracking has occurred.

Out-Gassing

All pure metals and alloys contain two or more of the common gases H_2, O_2 and N_2, in some form or other. Melting, pouring and solidifying in high vacuum lowers the level of residual gases by a factor of 10 to 100. For

(*Continued on page* 498)

Nickel and Cobalt Films

by Samuel Wein, CONSULTANT

● BOTH NICKEL AND COBALT FILMS, like other metals, may be precipitated on glass surfaces from aqueous solutions by suitable reducing agents. The reader should not infer that nickel films are intended to supplant the silvered surface. Nickel does not have the high brilliance or reflective properties of silver; however, it has other properties which should be of considerable interest to the mirror maker.

It is interesting to note that a nickel film on glass is bright and adherent, considerably more adherent, in fact, than the silver film obtained by the usual chemical reduction methods.

This article, dealing with nickel and cobalt films, will review the technical and patent literature on the chemical deposition of these metals with a view to adapting the process commercially to the formation of (1) nickel mirrors, and (2), the use of nickel as a "backing medium" for silvered surfaces in the place of copper.

Nickeling glass or other surfaces is by no means new. Nickel films are not common products on the open market, and they are highly specialized.

Mirrors

Nickel mirrors are limited in scope because of their reflectivity, as compared to that of silver films; however, their chief use is in optical research work and in scientific devices. Belozerskii finds that the co-efficient of reflection of a nickel film is about 0.86, when backed up with silver and subsequently with chromium. Fink and Knight used nickel mirrors on the inside of Dewar flasks, commercially termed "Thermos Bottles," because they tend to re-inforce the glass itself, and because they do not readily spoil with time, should a leak develop and the vacuum pressure change.

A more important application in mirror making is the formation of nickel films on the silvered (mirror) film. The use of nickel has many advantages in that the metal does not oxidize with time; it is much harder than the paints or the films of copper formed on the silvered glass by (1) galvanic techniques, or by (2) electrolytic (electroplating) means.

Methods Reviewed

The present series of methods about to be reveiwed are those in which an aqueous solution of nickel sulphate (or other soluble salt) is either acid, alkaline or neutral in nature, and is precipitated out of solution by means of a suitable reducing agent such as sodium hypophosphite, hydrazine, the tartrates, or formaldehyde. This is the common practice in silvering techniques.

Historical Survey

It is wise first to review the historical efforts of the early investigators, so as to form a clearer picture of the limited progress that has been made.

Dr. Abner Brenner and Miss Grace Riddell, of the National Bureau of Standards, Washington, D. C., disclosed in their earlier writings that the reduction of nickel, using sodium hypophosphite, was first observed by Wurtz as early as 1845.

This reaction was subsequently investigated by others, such as Fernberger and Smith who have shown that nickel can be completely precipitated from solutions of the sulphate by using disodium hydrogen phosphate, dissolving the nickel phosphate formed in a slight excess of phosphoric acid and electrolyzing the solution. They describe the deposit as dull grey in color, resembling to some extent the appearance of the platinum dish. The deposited nickel contained phosphorus.

von Liebig precipitated out nickel films on glass, in the same fashion that he precipitated out silver films, using an alkaline solution of nickel sulphate and Rochelle salts as the reducing agent. No details are given in his patent specification.

Curtius and Schrader formed nickel and cobalt films by precipitation with the use of hydrazine or hydroxylamine in ammoniacal solutions.

Taggart formed beautiful nickel deposits by electrolyzing solutions of nickel and sodium hypophosphite.

Other investigators who used hydrazine as the reducing agent for nickeling are Franzen and vonMeyer. Browne and Shetterly worked with nickel and cobalt solutions.

About the first reference discussing the specific use of sodium hypophosphite as a reducing agent to form mirrors is that accredited to Roux. His solution consists of:

Water	1000 grams
Nickel citrate	100 "
Ammonia	100 "
Sodium hypophosphite	100 "

Dr. Brenner, in discussing this reference, states that it "is to be differentiated from the spontaneous, non-catalytic type of reaction, such as that of Roux which indis-

criminately deposits a film of nickel over everything immersed in the solution, including the walls of the container and results in the complete impoverishment of the solution."

Dr. Sulzberger used nickel borate by dissolving it in an alkaline solution, adding first a few cubic centimeters of an alkaline palladium or platinum solution, then subsequently an alkaline solution of hydrazine sulphate or hydroxylamine. On heating this mixture, a very violent evolution of gas is observed as the nickel borate darkens in color. In 10 to 15 minutes the nickel film will be seen to have formed on the glass surface.

Bretau studied the reaction between nickel salts in solution which was either neutral, acid or alkaline, and in the presence of a noble metal catalyst such as palladium. The sodium hypophosphite solution was at room temperature. Unlimited amounts of hydrogen were set free.

Scholder and Hacken, and later, Scholder and Heckel used highly concentrated solutions of sodium hypophosphite, usually several hundred grams per liter, to effect reduction of the metallic nickel. Upon standing at room temperature, these highly concentrated solutions, it was found, would slowly decompose with time, making them unfit for further use. The reaction became vigorous when the temperature was increased.

Reduction in the hypophosphite solutions can be initiated by the presence of small amounts of palladium. As a matter of fact Feigel and Frankel used this reaction as a test to detect palladium. They added the unknown to a hot solution containing nickel and sodium hypophosphite and observed the formation of a powder or mirror of nickel on the wall of the test tube.

Paal and Frederici reduced nickel sulphate solutions to the metal by using an ammoniacal sodium phosphate and sodium tartrate solution, serving as the reducing agent. The temperature in this case was as high as 100°C. (212°F.). It was impossible to get complete reduction (precipitation) of the nickel by this method.

They likewise used highly concentrated solutions of sodium hypophosphite to obtain cobalt in flakes and powder form by the same technique described above.

A typical formulation they used consisted of:

Nickel sulphate	2-3 grams
Palladium chloride	0.005-0.05 gram
Hydrazine hydrate	0.5-1 cc.

Feigel and Frankel used such a reaction to detect palladium. They formed nickel mirrors on the inner wall of test tubes.

An alloy film between silver and nickel may be formed, according to Laval, by using the conventional mirror-making technique. This is made up of the following three solutions:

1) Silver nitrate	50 grams
Water	8 ounces
Ammonia (26° Be')	1½ "
2) Rochelle salts	50 grams
Water	8 "
3) Nickel sesquioxide	20 grams
Water	4 ounces

Solutions 2 and 3 are mixed, to which is added 4 ounces of water.

Borosilicate glass containing nickel carbonate or oxide can be reduced to metallic nickel, according to Fuha, by using an alkaline solution of potassium tartrate.

The patent by Prakst describes a procedure for the deposition of nickel on non-conducting materials by using ammoniacal solutions of nickel with hydrazine as the reducing agent. An unidentified noble metal catalyst was used to produce the reaction.

Fresenius and Bergmann find that nickel cannot be precipitated from solutions of its salts containing free mineral acids, but it can be precipitated from such solutions after the addition of the alkali salts of acetic, tartaric and citric acids.

Kelber finds that under alkaline conditions nickel oxide, or hydroxide, is reduced by formaldehyde. If nickel formate solutions are used in the presence of gelatin and glycerol, colloidal nickel is formed.

Dr. Brenner and Miss Riddell have popularized the knowledge of nickeling techniques. Their work will be reviewed in detail. Other major research contributions have been made by General Transportation Co. Their work, too, will be reviewed.

Surface Preparation

The glass or plastic surface to be coated with a film of electroless nickel or cobalt is essentially the same as that used in silver mirror making. The surface is first scrupulously cleaned, sensitized, super-sensitized, and subsequently nickel or cobalt deposited.

Cleaning

Any of the commonly known cleaning compounds may be used here, such as Trisodium phosphate ("TSP") with or without caustic soda. One that I personally like and one which gives excellent results with glass and plastics consists of:

Sodium gluconate	50 grams
Sodium hydroxide	50 "
Water	1 gallon

The temperature of the solution should be between 90° and 125° F. This should be followed by rinsing in running water.

Sensitizing

A comprehensive review of the chemical and patent literature of sensitizing (and super-sensitizing) compounds has been made by Wein.

A sensitizing compound usually consists of tin chloride dissolved in water to which has been added sufficient hydrochloric acid to prevent "hydrolysis" of the tin chloride in solution. In recent years compounds termed "wetting agents" have been added which aid in the adhesion of the deposited metals to the surface.

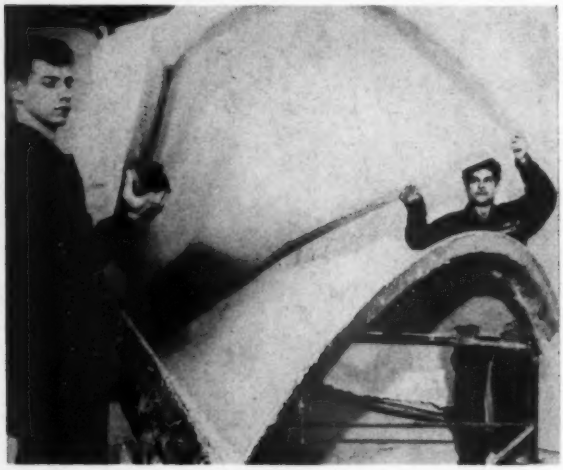
An excellent sensitizing solution used by the author for use with glass and plastics consists of:

Tin chloride	50 grams
Hydrochloric acid (conc.)	125 cc.
Triton X-100	10 cc.
Methanol	300 cc.
Water	1 gallon

(*Continued on page* 498)

Fiber glass mat is saturated with fire-retardent polyester resins in fabrication of 90 contact-molded columns for U.S. exhibit in Moscow.

New Design in Fiber Glass Construction



Completed fiber glass reinforced plastic section is removed from mold which is lubricated with release agent. Mold is also made of fiber glass.

• ONE OF THE FEATURES of the American National Exhibition in Sokolniki Park, Moscow, Russia, (July 25-September 5) was a 15,000 square-foot fiber glass-reinforced plastic pavilion. The entire structure, fabricated by Lunn Laminates, Huntington, N. Y., and designed by George Nelson, contained 630 individually molded units which formed 90 fiber glass columns, each 16 feet high. The columns were designed as hollow shafts to provide for rainwater drainage, and the inverted umbrella-shaped units at the top interlocked to form the roof.

A total of $151,000 was contributed by Owens-Corning Fiberglas Corporation, and 40 other U.S. companies, toward the cost of the pavilion. Suppliers, in addition to O-C-F, included the fiber glass division of Ferro Corp., Nashville, Tenn.; Hooker Chemical Co. (fire-retardent resins), Niagara Falls, N. Y.; and Lucidol division, Wallace-Tiernan (catalysts), Newark, N. J.

Photographic exhibit, showing detailed structure of honeycomb fiber glass structure. Note hollow columns which drain off rain water.

Russian Translations of Interest to the Glass Industry

Effect of Grain Size on Grinding

This was investigated by A. I. Korelova who points out, in *Steklo i Keramika* (Glass and Ceramics) *13*, No. 12, p. 5 (1956), that many previous studies of this effect were marred by the utilization of too polydisperse powders; if the powder contains a significant percentage of coarse grains, the process of grinding is determined mainly by these grains.

Four abrasives were fractionated to give 6 fractions each. Fraction A had 58 per cent of all grains in the range between 20 and 14 microns, and the coarsest grains present in a sizable amount had diameters between 28 and 20 microns; these made up 6 per cent of the grains. Fraction B had 64 per cent between 14 and 10 microns and 5 per cent between 20 and 14 microns. Fraction C had 66 per cent between 10 and 7, and 4.5

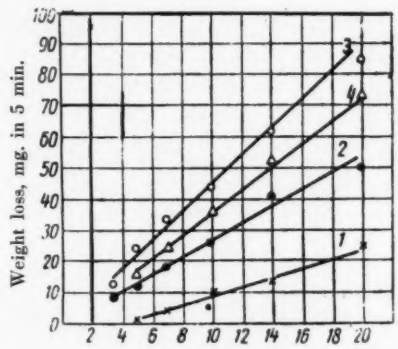


Fig. 1

per cent between 14 and 10 microns. Fraction D had 71 and 7 per cent in the ranges 7 to 5 and 10 to 7 microns, respectively. Fraction E had 65 and 3.5 per cent between 5 and 3.5 and 7 to 5 microns. Finally, Fraction F had 70 and 5 per cent in the 3.5-2.5 and 5-3.5 micron ranges, respectively.

Figure 1 shows the abrasion achieved by these fractions of quartz sand (line 1 of the graph), electrocorundum (line 2), boron carbide (line 3) and silicon carbide (line 4). The glass was ground on a machine with a cast iron grinding disc under a pressure of 100 grams/square centimeter at 100 revolutions per minute. The duration of grinding was 3 to 5 minutes. The graph shows that the mass of glass removed in 5 minutes increased almost proportionally to the grain diameter; the

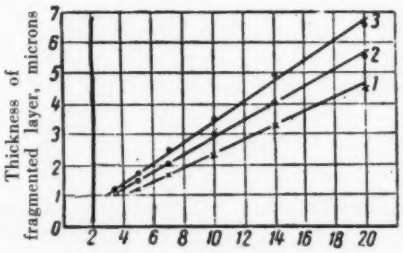


Fig. 2

deviation shown by the curve for quartz sand is attributed to breaking down of sand grains during the grinding process. The position of the 4 curves is determined by the micro-hardness of the abrasive. This hardness was 4800, 2900, 2100 and 1050 kg./square millimeter for boron carbide, silicon carbide, electrocorundum and quartz sand, respectively, while the glass used had 540-580 kg./sq. mm. For the first 3 materials the hardness is proportional to the rate of abrasion.

Not only the thickness of glass removed but also the thickness of the fragmented layer remaining on the glass surface was proportional to the grain diameter. This is illustrated in Fig. 2. Line 1 is for quartz, 2 for electrocorundum, and 3 for boron carbide.

Thus, if the coarse grains are removed, the effect of particle size on grinding is identical for fine and finest grains.

The "Ziralite" refractory

Some new refractory materials are described by A. A. Litvakovskii in *Steklo i Keramika* (Glass and Ceramics) *13*, No. 11, p. 11 (1956).

Blocks of these refractories were partly immersed in molten window glass for 15 hours at 1470°C and the decrease in their thickness was determined. Table I lists the results.

TABLE I

Refractory composition (Per cent)			Loss in Thickness, mm./24 Hours	
			Below Level	At Level
Al_2O_3	SiO_2	ZrO_2	of Molten Glass	of Molten Glass
50	18	32	0.62	0.82
50	14	36	0.24	0.68
54	16	30	0.56	0.65
65	35	0	2.25	3.85
96	4	0	1.20	1.60

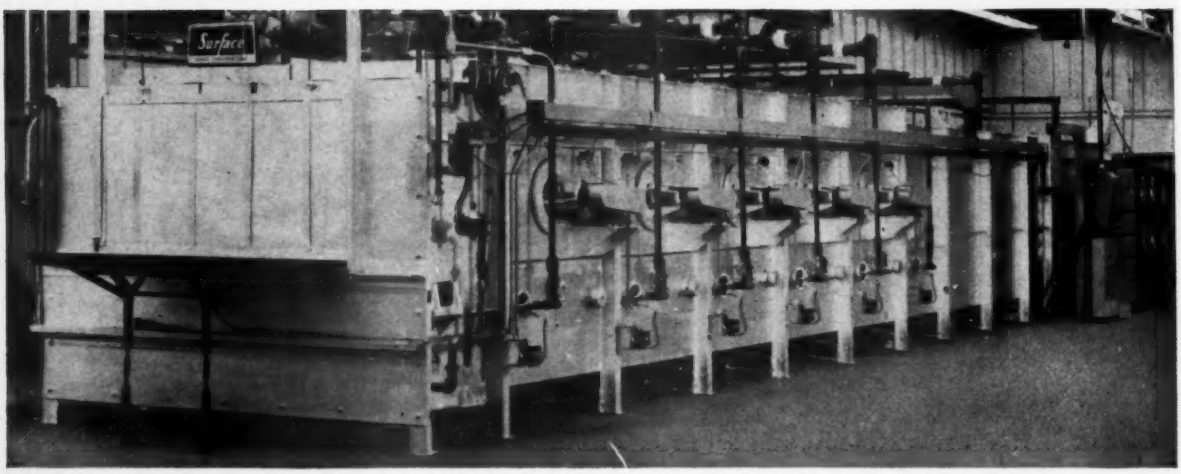
(*Continued on page* 502)

duplicate cycles with precision in modular lehr

The Surface modular lehr offers a final solution to the company which wants to replace obsolete equipment, but dreads the excessive engineering costs of new units.

This lehr is really a series of standardized modules, which can be linked together to reproduce any prescribed temperature curve. This type of design saves you money because it spreads the engineering costs over many modules, and makes assembly fast and economical.

This lehr has many other features. In many cases, it makes replacement more profitable than retaining outmoded equipment. Please let us tell you more about it.



The new Surface modular lehr, annealing television tubes.

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NEWS in The Glass Industry

George B. Skinta

William S. Bussey

Skinta Appointed V.P., Libbey Glass Division

George B. Skinta, formerly general manager, was elected vice president of the Libbey Glass division of Owens-Illinois by the board of directors at their quarterly meeting.

He has been with Libbey since 1933 and had previously served as sales manager of the Atlanta branch and southeastern regional sales manager.

$2.2 Million Research Bldg. for Foote Mineral

Foote Mineral Company is constructing a $2.2 million research and engineering building on its 53-acre research and engineering center near Exton, Pa. The multi-wing building will house the company's research and development department, central engineering department and administrative offices for the production department and will accommodate an approximate staff of 175 scientists and engineers. The company produces lithium and lithium chemicals; electrolytic manganese, zirconium and hafnium and ferro-alloys and minerals.

Glass Exhibition Honors 50 States

The fifty states of America, and Commonwealth of Puerto Rico, were represented in an exhibition by Steuben Glass in New York City from July 22 through August 7. The collection, "The United States in Crystal," took eleven years to prepare and consisted of a series of glass bowls, the central piece engraved with the Great Seal of the United States. Each of the other bowls is engraved with a theme representing that particular state; for example, Alabama (steel production in the industrial South), Alaska (Totem poles of idigenous culture), Illinois (the young Lincoln), New Jersey (Invention—the electric light bulb), and Pennsylvania (The Declaration of Independence).

The engravings were designed by the sculptor Sidney Waugh, with research assistance from the Institute of Early American History and Culture.

Bussey Elected V. P., British Weights & Measures

William S. Bussey, chief of the Office of Weights and Measures of the National Bureau of Standards, was elected vice president of the British Institute of Weights and Measures Administration at the Institute's annual general meeting on June 16. He is the first person outside of the United Kingdom who has been chosen to fill an office in the Administration. The Institute is concerned primarily with the exchange of information on problems of weights and measures.

Mr. Bussey, in this field since 1926, was state inspector of weights and measures for Texas, and later chief of the Texas division of weights and measures. He held this post until he joined the National Bureau of Standards as assistant chief of the office of weights and measures, having been appointed to his present position in 1950.

Dr. Silverman Lectures in Germany

Dr. Alexander Silverman, professor and head, Chemistry, and Emeritus of the University of Pittsburgh gave a lecture on Glass and the Space Age September 4, at Liebighalle, Germany as part of the sessions of the International Congress of Pure and Applied Chemistry. Dr. Silverman is president of the Commission on Inorganic Nomenclature of The International Union of Pure and Applied Chemistry. The lecture is part of a two-lecture series he gave during a two-week symposium at the Massachusetts Institute of Technology. The other lecture was on High Melting Glass Fibers.

New directors of Buck Glass Co., recently purchased by Knox Glass, Inc. Front row, left to right, W. A. Seger, vice president, sales, for Buck; Royden A. Blunt, president, Buck; Dr. A. W. Wishart, Knox president and chairman, and chief executive officer, Buck Glass; Clarence R. Deible, administrative vice president of Knox, and executive vice president of Buck. Back row, left to right, J. D. Lynch, secretary, Knox; Henry A. Koenig III, treasurer and controller, Buck; A. W. Lansberg, treasurer and controller, Knox; Richard B. Buck, secretary of Buck; W. M. LaVenture, general counsel of Knox and Thomas Wellington, New York law firm of Reynolds, Richards, Ely & LaVenture.

Karl Baumler

Parker McKinley Bitner

Pittsburgh Corning Appoints Baumler

Karl Baumler has been appointed manager of manufacturing for Pittsburgh Corning Corporation's plants in Sedalia, Mo., and Port Allegany, Pa. He will be responsible for directing the manufacturing activities of the plants as well as preparing manufacturing activities for future company expansion.

Mr. Baumler has been with Pittsburgh Corning since 1948.

Newbold Appointed Director of Research

William F. Newbold has been appointed director of research for the Brown Instruments division of Minneapolis-Honeywell Regulator Company. He succeeds Walter P. Wills who has been named technical advisor to the director of engineering.

ASTM Elects Thompson

Robert D. Thompson, chief development engineer for commercial and glass products, Taylor Instrument companies, was elected a director of the American Society for Testing Materials at the Society's 62nd annual meeting, June 21-26, in Atlantic City, N. J.

Anchor Hocking Begins San Leandro Operations

Anchor Hocking Glass Corporation has begun manufacturing operations at its new glass container manufacturing plant in San Leandro, Calif.

This installation, which covers a 23-acre tract, is one of three Anchor Hocking plants located on the West Coast operated by the subsidiary firm, Maywood Glass Co. W. E. Boschin is factories manager of the West Coast glass operations and the plant managers are J. K. Carnahan, San Leandro; J. G. Callinan, Maywood Glass Co., Los Angeles; and A. Podel, Pacific coast closure division of Anchor Hocking at South Gate, Calif.

The Maywood plant in Los Angeles manufactures flint, amber, emerald green and Georgia green glass containers for food products, wines, liquors, beers, carbonated beverages, drugs, pharmaceuticals and household chemicals. The South Gate, Calif. plant manufactures a complete line of closure for glass containers. The new San Leandro plant will initially produce glass, food and general purpose containers.

Knox Appoints Bitner

Parker McKinley Bitner has been named plant manager by Knox Glass, Inc., for the Knox, Pa., operations. He has been in the glass industry since 1932, having served as supervisor of quality control, plant manager and administrative assistant to the vice president of manufacturing at plants in Charleston and Wheeling, West Va.; Terre Haute, Ind.; Lancaster, N.Y.; and Toledo, O.

Sale of 6,000 Tons, Calcined Alumina

The General Services Administration will offer for sale in six months 6,000 short tons of calcined alumina, for which there is no stockpile requirement. The entire tonnage will be offered at one time on a competitive basis; however, bids may be submitted for less than the total quantity. Any such bid must be for a minimum of 40,000 pounds, or for a multiple of that amount.

Saint Gobain Corp. to Start Financing Program

American-Saint Gobain Corporation has started a financing program to raise funds to build a new $50,000,000 plate glass manufacturing plant, in Greenland, Hawkins County near Kingsport, Tenn. The plant is scheduled for completion during 1962 and will produce plate, sheet and rolled glass. Annual capacity will be about 40,000,000 square feet of one-fourth-inch plate glass.

The company has entered into an agreement negotiated by F. Eberstadt & Co. for the sale to the Prudential Insurance Company of America of up to $33,000,000 of six per cent first mortgage bonds due in 1982 with warrants for the purchase of 200,000 shares of authorized and unissued common stock at a price of $23.50 per share after November 1, 1963 and prior to November 1, 1971. The warrants are subject to certain restrictions with respect to their exercise or sale.

American-Saint Gobain's parent company, Compagnie de Saint-Gobain, Paris, France, is purchasing 275,000 shares of common stock at $17.30 per share under an option contract. It will also exercise all of its subscription rights by subscribing to $6,400,000 of the debentures and 153,600 shares of the common stock. This will make the parent company's holdings equal to approximately 57 per cent of the debentures to be outstanding and its 665,000 shares will be equal to approximately 57 per cent of the total number of shares of common stock to be outstanding. The new debentures are convertible into common stock at $22.50 per share until November 1, 1964, thereafter and until November 1, 1968 at $25 per share and thereafter and until November 1, 1971 at $30 per share.

American-Saint Gobain Corporation was formed by Compagnie de Saint-Gobain in 1956 and in 1958 acquired through merger the American Window Glass Corporation and Blue Ridge Glass Corporation. Company operations are presently in Arnold, Jeannette and Ellwood City, Pa.; Kingsport, Tenn.; and Okmulgee, Okla.

NEWS OVERSEAS

Solid State Structural Research in France

At a recent meeting of the "Association Française de Cristallographie" held in the Fourier Institute, Grenoble, in June, several résumés were given of solid state structural research current in ten of the more important laboratories in France, including

1) Lab. de Minéralogie et de Cristallographie, 1, rue Victor-Cousin, Paris 5e.
2) Centre Réchérches Macromolecules, 6, rue Boussugault, Strasbourg.
3) Centre National d'Etudes des télécommunications, 76, rue du Général Leclerc, Issy-les-Moulineaux, Seine.
4) Centres d'études Nucléaires de Saclay, Boite Postale 2, Gif-sur-Yvette, S.-et-O.
5) Institut des Sciences Géologiques de la facultée des Sciences, 1, rue Blessig, Strasbourg.
6) Institut Réchérche Chimie Applique, 12, quai Henri-IV, Paris.
7) Institut Fourier, Lab. de l'élétrostatique et de physique de Metal, Grenoble.
8) Lab. de Réchérches, Compagnie Pechiney, Chambery.

M. H. Curien described the program of work in the first laboratory on detailed atomic structures in various silicates and phosphates, and also some extensive studies on Uranium compounds and Metamict minerals. A very high standard of x-ray structural analysis is achieved in this laboratory where Prof. Wyart is the director.

M. Skoulios described the studies in the relatively new laboratory (2), under director V. Luzzati, where extensive work on soap materials is carried out particularly using low-angle x-ray scattering techniques.

In the third laboratory M. Burgeat described studies on Ge and Si crystals, using x-rays, infrared, and micro-hardness tests. M. Herpin outlined the neutron diffraction studies commencing in the laboratories at Saclay where the atomic pile has in the past year been brought into action. These include work on magnetic substances and on organic structures such as paratoluidine. Prof. S. Goldsztaub, described extensive studies, mainly of a geological nature, in laboratory (5) in Strasbourg.

The Inst. R. Chim Appl., (6), carries out studies on problems sponsored by Industry, this being a government laboratory but affiliated with the University of Paris so that a high proportion of research students work in the various sections, notably that of M. Mering. Detailed atomic structural studies are carried out using x-ray and electron diffraction methods, on single crystals and also on amorphous materials such as carbon.

M. E. F. Bertaut outlined the atomic structural studies in the laboratory in the Fourier Institute (director, Prof. Néel) on the isomorphous series of silicates, phosphates, germanates and arsenates, where the methods of x-ray analysis are also developed.

At Chambery, M. A. Saulnier discussed the studies on alloy systems, particularly light alloys of Aluminium, Titanium and Beryllium, using electron microscopy and diffraction.

The French Society of Crystallography holds frequent meetings, especially in Paris, and details of their activities can be obtained from from M. Curien at laboratory (1). A useful list of university research laboratories is given in "Laboratories Scientifiques; répertoire" published by "Office National des Universités et Écoles Françaises" in 1956 (Presses Universitaires de France), and some current activities in French laboratories is given in "Informations Scientifiques Françaises" published every three months by "Assoc. pour la Diffusion de la Pensée Française" (23, rue La Perouse, Paris.) in both English and French.

Society of Glass Technology to Meet

The Society of Glass Technology will hold its annual meeting in Harrogate, England, September 20 to 23. Among the papers to be presented are:

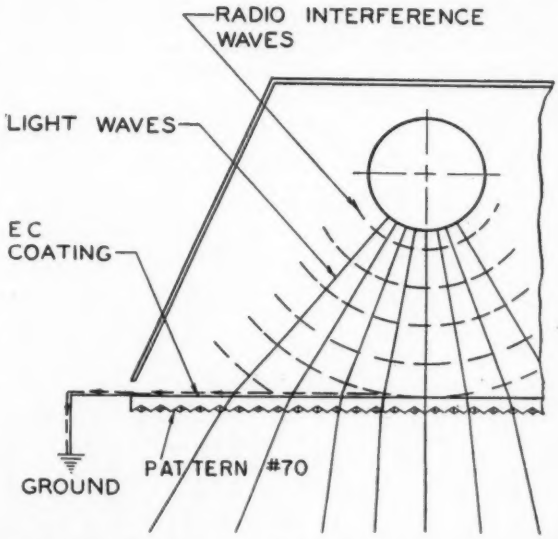
(1) *The Development of the Automatic Glass Bottle Machine*, a study of the technological changes in glass bottle manufacture which have led to complete automation in the glass container industry.

(2) *The Origin of the Reputed Quart.*

Glass Panel to Eliminate Radiated Interference

Corning Glass Works has developed a glass lighting panel that eliminates radio interference radiated from fluorescent lamps. The lens panel is coated on one side with a thin, transparent electrically-conductive film which intercepts the radiated interference and grounds it by means of a ¼-inch wide silver strip fired onto the film around the periphery of the glass.

The panel is designed for use in research laboratories where delicate electronic equipment is affected by high frequency radiation from fluorescent lamps.



Corning Glass Works' E-C pattern #70 low brightness lens panel shielding out radio interference radiated from a fluorescent lamp while transmitting the light waves. The interference is intercepted by a thin, transparent electrically-conductive film, permanently fired onto the back surface of the glass and is grounded by a ¼-inch wide silver strip fired onto the film around the periphery of the glass.

Industrial Engineering and Management Clinic

The 23rd annual Industrial Engineering and Management Clinic sponsored by the Industrial Management Society will be held at the Conrad Hilton Hotel, Chicago, Ill., November 5 and 6.

A two-day workshop featuring a seminar, (executive techniques for industrial engineering) will precede the clinic. It will be open to high-level administrators responsible to management for the overall objectives of the industrial engineering department.

Discussions will be held on developments in plant layout, methods and production control.

ACS Pacific Coast Regional Meeting

The American Ceramic Society will hold its 12th Pacific Coast Regional Meeting October 15, 16, and 17 at the Benjamin Franklin Hotel, Seattle, Washington.

Technical sessions are scheduled for October 15 and 16 from 9 a.m. to 5 p.m. and October 17 from 9 a.m. to 12 noon. The glass session on Friday, October 16, will include *Modern Glass Plant Instrumentation*, by R. K. Gunsaulus, applications engineer, ceramics and non-ferrous metals division, Bailey Meter Company, Cleveland, O.; *Batching Safeguards—The First Step Toward Homogeneous Glass*, by William Hanot, production engineer, Northwestern Glass Company, Seattle, Wash., and *Glass for Atomic Radiation Shielding Windows*, by Larry Penberthy, president, Penberthy Instrument Company, Seattle, Wash.

The glass and refractories joint session will also take place on Friday, October 16, and will include *Observations on the Deterioration of Various Basic Refractories used as Checker Bricks in a Window Glass Regenerator*, by M. L. Van Dreser and R. H. Cook, Kaiser Aluminum and Chemical Corporation, chemicals research laboratories, Milpitos, Calif.; *Testing and Using Fused Cast Blocks in Glass Melting Furnaces*, E. E. Humphrey, sales engineer, Corhart Refractories Co., Louisville, Ky. and *A Petrographic Study of Zircon Refractories after Service*, by Everett Thomas, chief ceramic engineer, Chas. Taylor & Sons, Co., Taylor, Ky.

The basic science sessions will be on Saturday, October 17, and will include *Behavior of Sodium Disilicate Glass on Iron at 1000° C in Vacuum and at Low Pressures of Oxygen*, by R. W. Cline, J. A. Pask and R. M. Fulrath, ceramic laboratory, department of mineral technology, University of California, Berkeley, Calif.; *X-Ray Strain Measurement Techniques for Ceramic Bodies*, Leonard N. Grossmand and R. M. Fulrath, ceramic laboratories, department of mineral technology, University of California, Berkeley, Calif., and *Kinetic Studies Between Gasses and Incandescent Metal Filaments*, (tentative title), H. U. Anderson, department of mineral technology, University of California, Berkeley, Calif.

Other technical sessions include Aircraft and Missiles, ductile ceramics session; Nuclear Ceramics, beryllium oxide session; and Nuclear Refractories and Refractories.

FINANCIAL DATA: SEMI-ANNUAL

American-Saint Gobain Corp.

	1959	1958
Net earnings	$ 289,634	(net loss) $361,259
Net sales	16,210,303	10,620,871

Corning Glass Works

	1959	1958
Net earnings	$ 11,765,538	$ 6,633,269
Net sales	87,814,256	70,680,587

Libbey-Owens-Ford Glass Co.

	1959	1958
Net earnings	$ 33,094,146	$ 5,941,827

Owens-Corning Fiberglas Corp.

	1959	1958
Net earnings	$ 7,239,118	$ 4,083,886
Net sales	100,821,042	77,486,605

Owens-Illinois Glass Co.

	1959	1958
Net earnings	$ 19,546,575	$ 16,436,963
Net sales	267,290,984	243,474,455

Pittsburgh Plate Glass Co.

	1959	1958
Net earnings	$ 16,285,700	$ 7,686,123
Net sales	169,613,521	132,256,539

Diamond Alkali Co.

	1959	1958
Net earnings	$ 5,201,563	$ 2,385,404
Net sales	65,922,622	56,360,364

Foote Mineral Co.

	1959	1958
Net earnings	$ 1,053,712	$ 1,039,477
Net sales	13,026,027	

General Refractories Co.

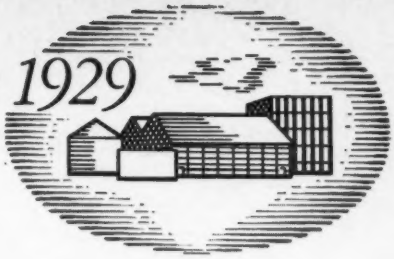
	1959	1958
Net earnings	$ 2,922,469.42	$ 830,955.46
Net sales	34,677,043.43	20,841,132.68

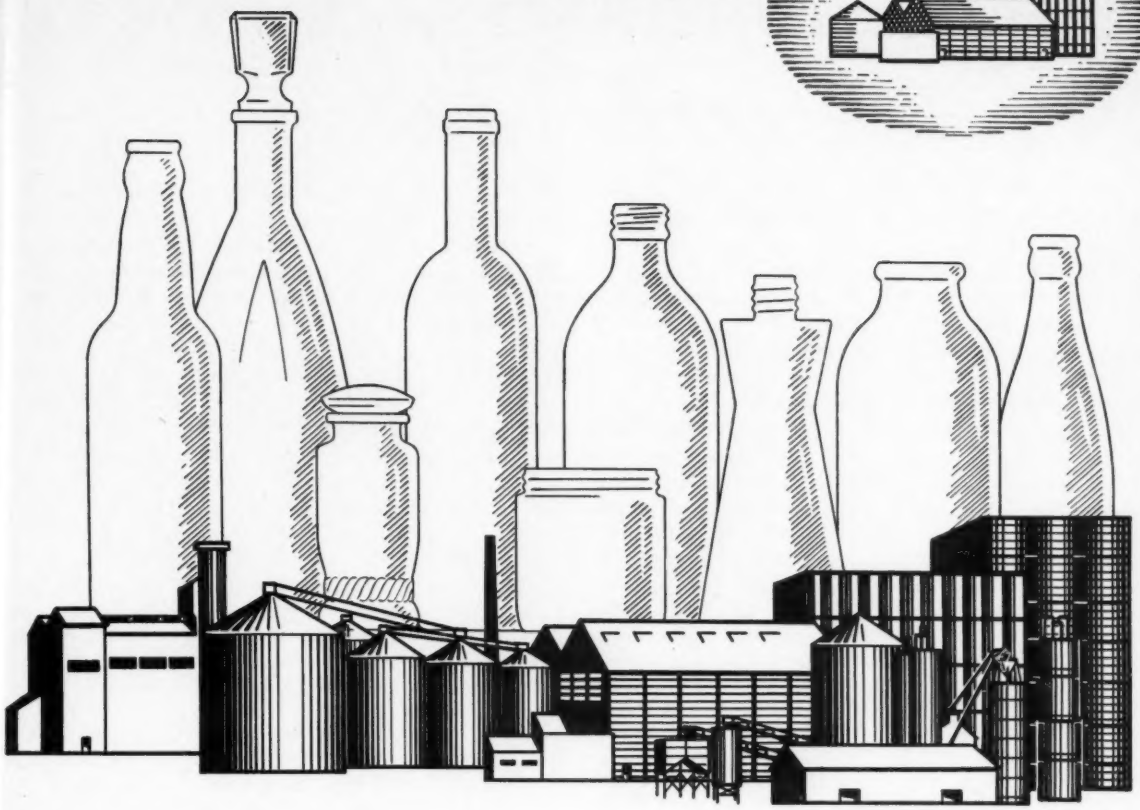
9-MONTH PERIOD

Harshaw Chemical Co.

	1959	1958
Net earnings	$ 1,920,523	$ 1,283,270
Net sales	52,123,090	45,434,074

TODAY *as in 1929*





there are clear advantages to WEST END SODA ASH

Supplying soda ash to meet the full requirements of western glass container producers has full-time priority at West End. From our first commercial manufacture in 1929 for a pioneer western glass container plant to today's large-scale production incorporating precise quality controls, ample storage and a unique system of fast, dependable service, West End has geared its progressive expansion specifically to the changing needs of this dynamic industry. It is only from the sound, functional base unique with West End that long-range dependability and realistic economy can be assured.

Coarse Dense Glassmakers' containing 1% $Na_2B_4O_7$

also 58% Coarse Granular

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DIVISION OF Stauffer STAUFFER CHEMICAL COMPANY

INVENTIONS AND INVENTORS

Annealing and Tempering

Apparatus for tempering curved glass sheets. Patent No. 2,876,592. Filed July 28, 1954. Issued March 10, 1959. No sheets of drawings; none reproduced. Assigned to Pittsburgh Plate Glass Company by Lloyd V. Black and James B. Moorhead.

The present invention relates to apparatus for tempering glass, and especially concerns uniform tempering of curved sheets of glass of various shapes, particularly automobile backlights which have a central portion curved to a comparatively gentle contour merging into portions having sharply decreasing radii of curvature, thereby forming opposed end sections, the tangents to which are substantially perpendicular to the tangent at the center of the glass sheet.

Apparatus is provided for moving the nozzles in a predetermined pattern spaced a fixed distance from the glass sheet surfaces, and means are included for varying the contour of nozzle movement to conform to the shape of the glass sheet being tempered. A typical apparatus utilizes two vertically spaced sets of interlinked nozzle members, each oscillatable along substantially horizontally extending tracks comprising vertically adjustable track members. The tracks are mounted in a frame horizontally reciprocable in quadrature to the horizontal component of nozzle member movement. Curved glass sheets are held stationary between the nozzle members. The opposite curved glass sheet surfaces are exposed to blasts of tempering fluid which impart overlapping circular patterns to the curved glass by virtue of the relative movement between the nozzles and the glass. This movement insures a uniform tempering pattern in the glass. The vertical adjustment of the track members enables changing the pattern of nozzle movements to conform to different glass curvatures.

One object of the invention is to provide apparatus for tempering sheets of material of varying curvature wherein blasts of fluid are directed normally to the surfaces of the material to be tempered regardless of the shape of the material.

There were 11 claims and 12 references cited in this patent.

Method of bending and cutting glass sheets. Patent No. 2,880,553. Filed September 19, 1956. Issued April 7, 1959. No sheets of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by Frank J. Carson.

It is known that the peripheral edge or margin of a glass sheet will be stronger and more resistant to chipping or fracture if a compressional stress is developed in such marginal areas. Accordingly, to produce suitably edged glass articles, such as automobile windshields, which in keeping with the design of modern cars are bent to increasingly sharp curvatures, provision is made in the molds by which the glass sheets are bent to orient the known stresses, such as tension and compression, and to develop a suitable outline in the sheets that will posses compressional stress.

The present invention comprises a method of producing pattern-cut bent glass sheets having a marginal edge stress therein from blank size glass sheets in which a pair of blank size glass sheets are first heated and then bent into conformity with the shaping surface of a bending mold. After being bent, portions of the sheets are cooled at a different rate than other portions to establish a compression stress in the bent sheets which are marked prior to being removed from the mold. After being marked, the bent sheets are located on a cutting machine and oriented thereon by means of the mark whereby the cutting machine is able to accurately pattern-cut the sheets through the areas thereof in compression.

There were four claims and 12 references cited in this patent.

Feeding and Forming

Nickel base alloy glass molding elements and method of making same. Patent No. 2,833,646. Filed June 20, 1955. Issued May 6, 1958. No sheets of drawings; none reproduced. Assigned to The International Nickel Company, Inc., by Gerald L. Lee.

The present invention relates to an improved nickel-copper casting alloy having a high combination of properties, including good castability, resistance to the deleterious effects of corrosion and heat shock and, more particularly, to cast glass molding elements, i. e., glass molds and plungers, made from a special nickel-copper alloy and the process of producing the same.

Generally speaking, the invention involves a special nickel-copper casting alloy containing about 20 to about 40 per cent copper, about 0.5 to about 17 per cent aluminum, about 0.01 to about 0.5 per cent titanium, about 0.03 to about 0.5 per cent boron, about 0.2 to about 1.5 per cent silicon, about 0.5 to about 2.5 per cent manganese, carbon up to about 0.2 per cent, about 0.02 to about 0.1 per cent magnesium, and the balance essentially nickel, with the nickel content being about 50 to about 70 per cent. All percentages of ingredients given herein are by weight.

A special method comprises establishing a bath containing between about 20 and about 45 per cent copper, with the balance essentially nickel; oxidizing the bath, for example, by an addition of about 0.25 to 0.35 per cent nickel oxide to remove oxidizable impurities; deoxidizing the bath with, for example, about 0.25 to about

0.5 per cent of silicon; adding the required amount of manganese, usually at least about 0.5 per cent manganese; carburizing the bath with more (for example, an addition of about 0.1 to about 0.2 per cent of carbon; thereafter adding about half the aluminum required to give the desired final aluminum content, preferably about 3.5 to about 5.5 per cent aluminum; adding the titanium required to give the desired final titanium content in the castings, preferably about 0.3 to about 0.4 titanium; then adding the remainder of the aluminum to give the desired final aluminum content in the castings which preferably is about 3.5 to about 5.5 per cent; adding the desired amount of boron, preferably about 0.06 to about 0.1 per cent boron; adding at least about 0.05 per cent magnesium along with or after said boron addition; and then casting metal from the bath. It is important that the boron addition be made subsequent to the last aluminum addition in order to provide proper fluidity and to clear up films formed on the molten metal.

There were seven claims and the following references cited in this patent.

United States Patents

1,059,709, Byrnes, Apr. 22, 1913; 1,115,238, Parr, Oct. 27, 1914; 2,048,163, Pilling et al., July 21, 1936; and 2,150,094, Bieber, Mar. 7, 1939.

Foreign Patents

140,756, Great Britain, Jan. 20, 1921.

Glassware Lathe. Patent No. 2,818,683. Filed November 10, 1954. Issued January 7, 1958. No sheets of drawings; none reproduced. Assigned to Bethlehem Apparatus Co., Inc. by Chauncy W. Nieman and James B. Lawrence.

This invention relates to lathes particularly suited for glassworking operations including the making of ring-seals, T's, flanges, tapers, fusings, closures and the like.

In accordance with the invention, the headstock and tailstock frames are each provided with a work chuck mounted in a bearing arrangement which permits adjustment of the plane of rotation of the chuck with respect to the plane of the frame and adjustment of the axis of rotation of the chuck vertically and horizontally in the plane of the frame. Preferably, compensation for effects of temperature changes upon the chuck body is obtained by spring-loading one of the bearings. By such bearing arrangements for the chucks, their axes of rotation may initially be brought into coincidence with each other and with a straight line parallel to the lathe bed and may be returned to such position should the relationship of parts be distributed.

Each chuck has a peripheral track with bearing surfaces which converge towards a plane normal to the axis of rotation of the chuck and which are engaged by pairs of rollers carried by three arms. The arms are adjustably pivotally mounted on the frame and at least two of them are also adjustable normal to the axis of rotation of the chuck.

The tailstock and headstock chucks are driven in synchronism by an elongated pinion running the full length of the lathe bed and engaging chuck-driving gears mounted on the respective frames.

There were 10 claims and 12 references cited in this patent.

Furnaces

Continuous glass melting furnace. Patent No. 2,860,449. Filed July 7, 1955. Issued November 18, 1958. No sheets of drawings; none reproduced. Assigned to Thermal Engineering Company by Elisha W. Paxton.

A novel furnace design is shown for melting glass. The furnace is rectangular in shape and provides continuous production of glass. The furnace includes a first firing port extending across substantially the entire length of a first side of the basin and a second firing port across substantially the entire length of a second side of the basin and opposite the first. Firing means are provided for producing a flame blanket alternately orginating at said ports and extending over substantially the entire surface of the bath. A submerged throat is placed through a third side of the basin, and this throat includes an inlet underlying the paths of the flame blankets. The method also comprises heating the surface of the bath by means of a single closely confined flame that covers a single integrated melting and refining area. The flame is produced in alternative succession at oppositely disposed origins and is said to displace molten glass downwardly from the melting and refining area and withdraw molten glass in a direction transverse to both flame paths and to the direction of downward displacement.

It is further stated that the melting rate is so rapid that the raw materials rarely, if ever, reach the walls, and there is no relatively-fixed so-called "foam line." Thus, the foam from the melting raw materials cannot continuously exert its particularly corrosive properties upon the basin walls, as in conventional furnaces, since it, too, rarely, if ever, reaches them.

There are no unidirectional horizontal movements of hot glass at the surface, and the movements that do occur are extremely transient and wandering in character, being so superficial that they readily change their direction with reversals of the firing.

There were 9 claims and the following references cited in this patent.

United States Patents

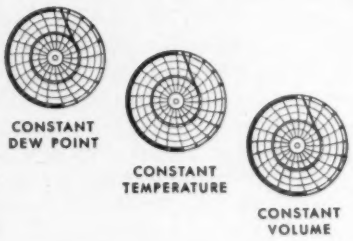
1,828,833, Drake, Oct. 27, 1931; 2,179,848, Forter, Nov. 14, 1939; 2,249,714, McBurney, July 15, 1941; 2,300,426, Longenecker, Nov. 3, 1942; and 2,328,917, Longenecker, Sept. 7, 1943.

Apparatus and method for making glass. Patent No. 2,859,261. Filed October 1, 1953. Issued November 4, 1958. No sheets of drawings; none reproduced. Assigned to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain Chauny & Cirey by Pierre Arbeit.

This invention relates to furnaces for the production of glass or other vitreous materials. The invention particularly concerns improvements in furnaces operating at least in part by Joule effect by means of electrodes immersed in the fused bath.

(*Continued on page* 506)

Do You Want
Uniform M-T-V* Air
for any purpose?



● *This self-contained unit, available in a wide variety of cfm capacities, is adaptable to different controlled-air supply requirements. In any climate it needs no roof but may be installed outside the building.*

Manufactured under U.S. Patent 2,632,315.
Other patents pending.

● If you need a constant air delivery, at predetermined **moisture, temperature* and *volume,* for any industrial or commercial purpose, an adaptation of the versatile Coblentz Dry Air System may solve your problem, promptly and economically.

With the proper Coblentz installation, you can have "wind" to cool bottle-forming molds at a uniform rate, day and night, winter and summer — and thus assure high productivity at lowest cost. With another Coblentz adaptation you can have constant, safe, operating atmosphere for a room full of computer tubes or electric switches. In the glass industry, the thermal efficiency of Coblentz Dry Air Coolers is setting records for economical, trouble-free operation of air compressors and the air-powered equipment they supply.

Where plant steam is not readily available, the Coblentz Dry Air System may be equipped to switch automatically from refrigeration to heat pump operation, as weather changes call for heating instead of chilling the air supply. Temperature constants may be provided between 38° F. and 98° F.; air pressure from 5″ to 20″ static pressure (water column); air delivery from 1000 cfm to 30,000 cfm from a single Coblentz unit.

If you have a need for "Uniform M-T-V Air," tell us your problem. No obligation.

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Research Digest

Glass Structure and the Effects of "Melting History" on Glass Properties

• IN PART I OF THIS SERIES consideration of the kinetics of the interaction of silicate melts and silica led to the development of a structural model for glass melts. In a melt produced just above its liquidus temperature a structural unit characteristic of the primary crystalline phase persists. At more elevated temperatures a degradation and reorganization of the structural unit occurs, leading to a distribution of silicate units. As was pointed out, the quenching of the latter melt should "freeze in" the structure established at this elevated temperature. Thus the conclusions regarding melt structure should find application in the general field of glass structure.

The varied observations which have been made dealing with glassmelting, melt structure, and glass structure indicate that investigations which attempt to relate the physical properties of glass to its structure must be preceded by a definition of the origin of these properties. To date no delineation has been made of the properties which arise from the nature of the structural units established in the melting process as opposed to those stemming from the physical arrangement of these units with respect to one another. Inasmuch as the latter properties are related to the thermal history of the glass, McKinnis and Sutton* propose the introduction of the concept of "melting history" as a means of gaining insight into the former class of properties.

In pursuing the concept of the melting history of glass, and the manner in which it might affect the physical properties of glass, a series of exploratory experiments was designed to establish, at least qualitatively, the validity of such an idea. Inasmuch as the bases of melting history are founded on a rearrangement of the melt on an atomic scale, viscosity was selected as the physical property which should best reflect those predicted structural changes in the melt. By the same reasoning, tensile strength measurements on glass fibers were selected as the physical property to be measured in the vitreous state.

Viscosities were determined in a thermally insulated platinum crucible, which also served as the resistance heating element. The unit was powered by a 7½-kva. transformer, coupled with a saturable core reactor. The viscometer head was a Brookfield, Model RVT, having an accuracy of one per cent full-scale deflection and capable of measuring a wide range of viscosities, depending on the size and geometry of the bob and crucible. The precision of this instrument is greater than one per cent. The viscometer bob, also of platinum, measured one in. in length and ½ in. in diamter.

Temperature indication and control were maintained in the 1½-in. section of the viscometer by means of four Pt-Pt-13 per cent Rh thermocouples, three of which were welded at 1-in. intervals along the length of the heated zone, whereas the fourth was welded diametrically opposite the middle thermocouple. The middle one of the three thermocouples was used for control, and the other three sufficed for temperature indicators. Temperature control was maintained by means of a Wheelco Capacitrol, and all temperature readings were obtained with a Leeds and Northrup Type k-2 potentiometer. With proper adjustment of the current path through the platinum crucible a quite consistent temperature could be attained. The maximum deviation along the 1½-in. heated section was± 4°C. for any particular set of readings; the maximum departure in the control temperature was ± 3°C.

E-glass, a borosilicate composition, was used to calibrate the viscometer, inasmuch as viscosity-temperature relations for this particular composition are known with considerable accuracy from other measurements. The criteria established for obtaining a set of readings were as follows: The controller was set at some fixed temperature, and the melt was allowed to equilibrate, i. e., until a constant viscosity and temperature were attained. Viscosities and corresponding temperatures were then taken every minute for at least five minutes, at which time the temperature differential along the heated zone was taken. Using this technique, the viscometer was calibrated over the interval 1204° to 1482°C., the temperature range to be investigated. The viscometer was quite satisfactory. With experience it was found that proper alignment of the temperature controls could be attained in about three minutes, for an indicated 56°C. temperature rise. This rapid response allowed a complete temperature-viscosity curve to be obtained over an interval of 275°C. in less than 1 hour and with a considerable degree of precision (± 18 poises, ± 3°C.). It was found that viscosity lagged temperature by not more than 30 seconds at the maximum.

A glass of essentially E composition designated as ER-348, was selected for these melting history studies, as this glass composition exhibits little volatilization. Undue loss of volatile constituents during the melting history-viscosity studies, would tend to obscure any change in viscosity as the result of structural rearrangement which might occur.

Starting from batch, the composition was subjected to a melting history of nine days at 1204°C. and an additional five days at 1260°C. (the liquidus of this composition is 1110°C.) after which it was water-quenched. Microscopic examination at a magnification of 450X revealed no crystalline material. This cullet

(*Continued on page* 496)

*Journal of the American Ceramic Society, May, 1959.

CURRENT STATISTICAL POSITION OF GLASS

Employment in the glass industry during June, 1959, was as follows: *Flat Glass:* a preliminary figure of 29,200 for June, 1959, indicates a decrease of 0.3 per cent under the adjusted figure of 29,300 reported for May, 1959. *Glass and Glassware, Pressed and Blown:* an increase of 2.9 per cent is shown by the preliminary figure of 88,300 reported for June, 1959, when compared with the adjusted figure of 85,800 reported for May, 1959. *Glass Products Made of Purchased Glass:* the preliminary figure of 15,000 given for June, 1959, is an increase of 2.7 per cent over the adjusted figure of 14,600 reported for June, 1959.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	July, 1959
Food	1,466,000
Medicinal and Health Supplies	1,156,000
Chemical, Household and Industrial	969,000
Toiletries and Cosmetics	898,000
Beverage, Returnable	1,105,000
Beverage, Non-returnable	167,000
Beer, Returnable	291,000
Beer, Non-returnable	1,090,000
Liquor	949,000
Wine	342,000
Sub-total (Narrow)	8,433,000

Wide Mouth Containers

Food	*3,716,000
Medicinal and Health Supplies	368,000
Chemical, Household and Industrial	145,000
Toiletries and Cosmetics	251,000
Packers' Tumblers	37,000
Dairy Products	159,000
Sub-total (Wide)	*4,676,000
Total Domestic	13,109,000
Export Shipments	213,000
TOTAL SHIPMENTS	*13,322,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production July 1959	Stocks July 1959
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,870,000	7,204,000
	Wide Mouth	*4,772,000	*7,239,000
Beverage, Returnable		979,000	1,657,000
Beverage, Non-returnable		132,000	203,000
Beer, Returnable		302,000	481,000
Beer, Non-returnable		1,061,000	819,000
Liquor		1,130,000	1,467,000
Wine		332,000	723,000
Packers' Tumblers		28,000	107,000
Dairy Products		151,000	295,000
TOTAL		*13,757,000	*20,195,000

*This figure includes Fruit Jars and Jelly Glasses.

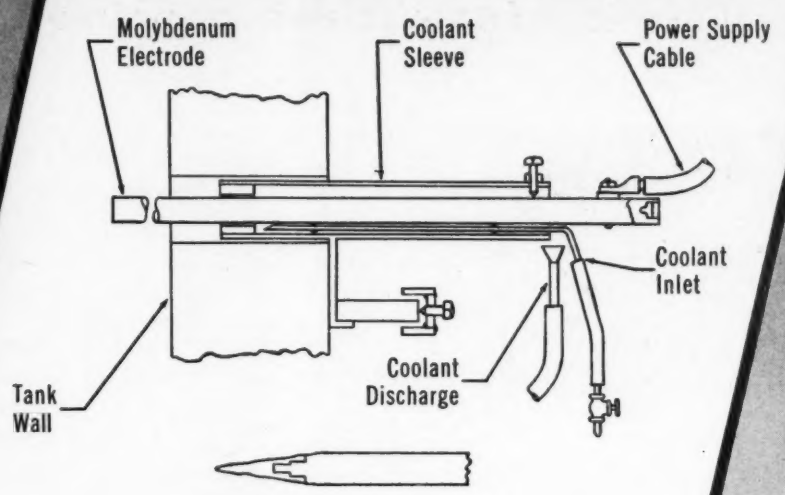
Payrolls in the glass industry during June, 1959, were as follows: *Flat Glass:* An increase of 2.2 per cent is shown in the preliminary $17,032,607.03 given for June, 1959, when compared with May's adjusted $16,661,390.26. *Glass and Glassware, Pressed and Blown:* An increase of 2.7 per cent is shown in the preliminary $33,921,661.77 reported for June, 1959, when compared with the previous month's adjusted $33,013,300.32. *Glass Products Made of Purchased Glass:* A preliminary figure of $4,843,427.40 was reported for June, 1959. This is an increase of 2.2 per cent when compared with the adjusted figure of $4,737,676.20 for June, 1959.

Glass Container Production based on figures released by the Bureau of the Census, Industry Division, was 13,757,000 during July, 1959. This is an increase of 0.3 per cent over the previous month's production figure of 13,713,000 gross. During July, 1958, glass container production was 12,698,000 gross, or 7.6 per cent under the July, 1959 figure. At the end of the first seven months of 1959, glass container manufacturers have produced a preliminary total of 89,488,000 gross. This is 7.4 per cent more than the 83,293,000 produced during the same period in 1958.

Glass Container Shipments during July, 1959 came to 13,322,000 gross, a decrease of 3.2 per cent under June, 1959. Shipments during July, 1958 amounted to 12,267,000 gross, or 7.9 per cent less than July, 1959. At the end of the first seven months of 1959, shipments have reached a preliminary total of 86,996,000 gross, which is 7.8 per cent more than the 80,806,000 gross shipped during the same period the previous year.

Stocks on hand at the end of July, 1959 came to 20,195,000 gross. This is 2.1 per cent more than the 19,774,000 gross on hand at the end of June, 1959, and 3.5 per cent more than the 19,487,000 gross on hand at the end of July, 1958.

Hot molybdenum ingots are forged into round billets, then further processed to make 1¼-inch diameter electrodes for glass melting furnaces using the Penberthy electrode assembly shown in the diagram.



Electrodes are joined by threaded ends to provide maximum use

Fansteel Molybdenum Electrodes

for electric melting...

here's what they cost:

Based on actual operational costs covering a production of 16,027 tons of flint glass over a period of several months, electrode cost amounted to *only 2½ cents per ton!*

here's what you get:

1. Increased production (10 to 30%)
2. Longer furnace wall life
3. Improved glass quality

FANSTEEL ELECTRODES CAN BE INSTALLED WITHOUT FURNACE SHUT-DOWN . . . are 99.9% pure, give off a colorless oxide, have high thermal and electrical conductivity, and high temperature strength. Write for more complete information.

K577

FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U. S. A.

New Equipment and Supplies

Pallet Conveyor

M-H Standard Corp., Jersey City, N.J., is manufacturing a gravity conveyor capable of handling up to 3000 lbs. pallet loads at slopes as low as ⅛″ per foot. The rails are 10′ long with heavy duty antifriction bearing wheels on 3″, 4″, 5″ and 6″ centers and can be adjusted in width and elevation. Mounting supports on 5′ centers can also be adjusted or the rails may be mounted directly on the floor.

Non-palletized Load Truck

Lewis-Shepard Products, Inc., Watertown, Mass., has developed a new side-shift load grab truck with multi-purpose arms for non-palletized loads such as drums, cartons, crates, bales, and rolls. The arm-gripping surface is smooth or rough-top, rubber bonded to steel sheets which are screwed to the plates. Other surfaces are available.

High-Temperature Resistors

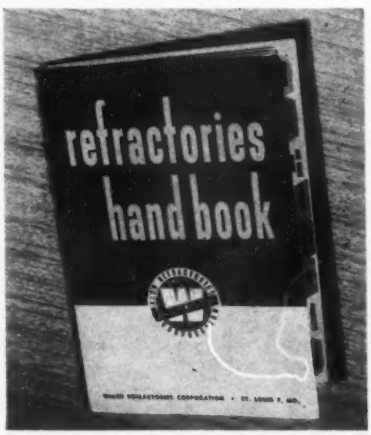
International Resistance Co., Philadelphia, Pa., is manufacturing a high-temperature resistor rated at 15 watts which is constructed of inorganic materials for protection against flame or decomposition at overload conditions. The resistance element is wound on a glass fiber core and secured to the alloy-coated leads. It is available in values from 1 to 25,000 ohms, with standard 10 per cent tolerance, or 5 per cent on special order.

Conversion Factor Chart

Precision Equipment Co., Chicago, Ill., has available a conversion factor wall chart which includes common conversions such as inches to centimeters or watts to h.p. and the more difficult conversions of atmospheres to Kgs/sq. cm.; cm./sec. to miles/hr.; cu. ft. to liters; microns to meters and quintal to lbs.

Refractories Handbook

Walsh Refractories Corp., St. Louis, Mo., has issued its revised Refractories Handbook. Included in the handbook are the company's glass industry refractories, FC-101, fusion cast material; low K factor insulating refractory; Insulflux, and Zircon refractory for use in glass furnace bottoms. A convenient color tab indexing system is provided for reference.



Vacuum Heat Furnace

F. J. Stokes Corp., Philadelphia, Pa., has designed a new vacuum heat-treating furnace for application in bright finishing of stainless steel alloys, hardening of precipitation-type alloys, outgassing of reactive metals and degassing of alloys and heat-sensitive materials.

A 13 KW Trent electric furnace with folded and formed heating elements provides controlled heat to a 28″ long Stokes vacuum retort. Constant temperatures up to 1850° F., controllable to plus or minus 1 per cent, comprise the uniform hot zone which is 12″ long x 10″ in diameter. The furnace is hydraulically lowered clear of the retort for rapid cooling.

A Stokes Microvac pump with a 6″ ring-jet diffusion pump provides an ultimate blank-off vacuum in the retort of less than .01 micron and inleakage is no greater than 10 microns per hour at 1 micron pressure. The condition of critical components can be observed at a glance by a special system of indicating lights. The whole unit operates on 220 volt, 3 phase, 60 cycle electrical input.

Precision Grinder

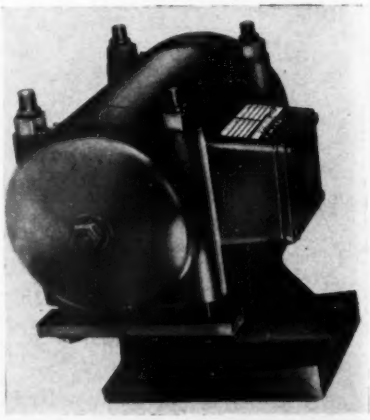
Ashcombe Co., York, Pa., has developed a precision grinder which is said to grind holes as small as .02″ to tolerances of plus or minus .0001″ at spindle speeds in excess of 300,000 rpm. It can be used on extremely hard materials such as glass, ceramics, carbides and hard metals with diamond and carbide tools. The head is ⅜″ in diameter by ½″ long.

Bin Vibrators

Eriez Mfg. Co., Erie, Pa., has added two new units to their HI-VI line of bin vibrators to deliver a more powerful impact which will prevent clogging, sticking and bridging of stubborn materials in larger, heavier bins than those serviced by other V3A models. They are for use on bin walls of ¼″ maximum thickness with a capacity of 50 cubic feet. No control box or rectifier is needed to provide for power conversions from DC to AC.

External Vibrator

B. W. Elliott Manufacturing Co., Inc., Binghamton, N.Y., has developed an external vibrator for use on bins, hoppers, chutes, tables, jolters, classifiers, screens and concrete forms. Avail-



able in three models, weighing 30, 40 and 60 pounds, respectively, the vibrator delivers impacts ranging from 500 to 1400 pounds with 3,600 vibrations per minute. It is totally enclosed and may be used permanently, or as a portable unit.

Automatic Batching Control

Toledo Scale Corp., Toledo, O., has introduced a new and advanced method for automatic batching control designed to provide control of the entire batching operations from a central remote location.

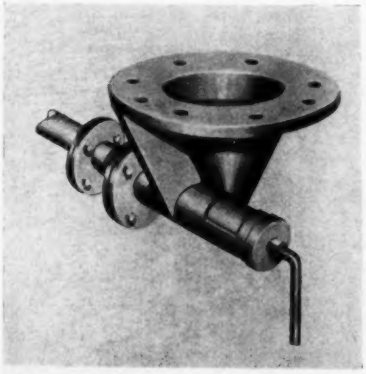
A batchboard unit that works in conjunction with the company's Remocon batching systems sets up the desired batch weight of each ingredient in a formula. The unit is inserted in the control panel receptacle and the formula can be delivered in multiple or partial batches. Each batchboard unit can handle as many as 20 ingredients for each formula.

Spandrel Glass

Virginia Glass Products Corp., Martinsville, Va., is producing glass spandrels for curtain wall construction and building material. The spandrels are 62" x 84", in 22 standard ceramic colors which are permanently fused to the back.

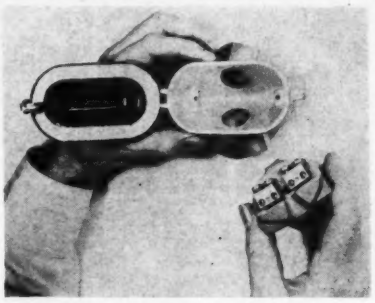
Material Intake Valves

U.S. Hoffman Machinery Corp., New York, N.Y., has available a new material intake valve which can be used with high-vacuum pneumatic systems employed in the removal or transport of dry, free-flowing, powdery or granular materials from hoppers, bins and dust collectors. The valve is equipped with standard 8" flanged connections and can be used on 2" through 6" pipe lines. A separate air inlet prevents connected equipment from exposure to full suction of the vacuum system.



Thermocouple Head Assembly

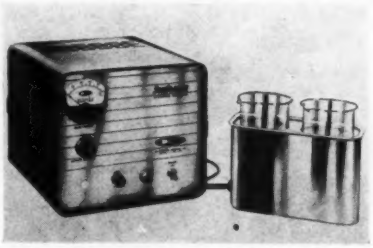
Pyrometer Co. of America, Inc., Penndel, Pa., has a new thermocouple head assembly with a ceramic block and a hinged, pressed or stainless steel



cap which can be flipped open or shut. The cap uses a positive catch and a moisture- and heat-resistant gasket to shield the wires against corrosion, abrasion, and mechanical damage. The block will take wires up to 8 gauge and can be modified simply to fit other standard heads.

Ultrasonic Cleaner

The Narda Ultrasonics Corp., Westbury, N.Y., is manufacturing an ultrasonic cleaner capable of washing and



rinsing the contents of two glass beakers simultaneously. The cleaner may be used in small parts cleaning, laboratory processing and investigation of various ultrasonic phenomena. The unit consists of an ultrasonic generator, two 400-cc. Pyrex glass beakers and a transducerized ultrasonic tank.

Catalogs Received

Heavy duty checkweigher. (4 pages) Folder describes development, features and optional accessories of Model 9460 heavy duty, high speed, automatic checkweigher. Illustrated.

TOLEDO SCALE CORP., Toledo, Ohio

Ceramic insulated thermocouple. Specifications, charts and data on Aer O Pak ceramic insulated thermocouple wire, conductors and fittings. Two catalogs.

AERO RESEARCH INSTRUMENT CO., INC., Chicago, Ill.

Multiple pressure readout. (12 pages) Catalog 30B1000 describes multiple pressure readout system for measuring and recording different pressures simultaneously with single transducer. Illustrated.

FISCHER & PORTER CO., Hatboro, Pa.

Pyroceram materials. (8 pages) Description of the glass-ceramic and its electrical, mechanical, thermal and chemical properties. Detailed data on two types.

CORNING GLASS WORKS, Corning, N. Y.

Automatic case packer. (4 pages) Describes special features in which bottles are raised into the case. Output is 20 cases of 24 bottles per minute. Illustrations, diagrams and charts.

W. F. & John Barnes Company, Rockford, Illinois

Alumina products. (16 pages) Chemical analyses and physical data on calcined alumina, low-soda calcined; tabular, active and hydrated.

KAISER CHEMICALS, Pittsburgh, Pa.

Ultrasonic grinding service. (4 pages) Description and illustrations of products machined by ultrasonic method.

PRECISION GLASS PRODUCTS CO., Philadelphia, Pennsylvania

Thinlite curtain wall. (11 pages) Designed as a total wall, not a collection of stock shapes and parts assembled on the job. Illustrations of various size combinations and fired-on ceramic colors. Specification details.

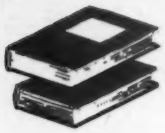
OWENS-ILLINOIS, Toledo, Ohio

Mechanical vibrating equipment. (5 pages) Bulletin describes glass plant operations for mechanical vibrating equipment. Suggested uses for vibrating conveyors given by a glass plant flow sheet. Illustrations of equipment in operation for batch handling, cullet collection and other jobs.

CARRIER CONVEYOR CORP., Louisville, Ky.

Cellulose acetate coating. (35 pages) Detailed information on selection of particular types of cellulose acetates as a film-former in protective and decorative coating of glass and fabrics. Illustrated.

EASTMAN KODAK CO., Kingsport, Tenn.



NEW BOOKS

Diderot Pictorial Encyclopedia of Trades and Industry (Two Volumes, 1959). Dover Publications, Inc., New York; 485 plates and 920 pages; $10 per volume. Two-volume set: $18.50.

Illustrations and descriptions offer an extensive record of the state of manufacturing and the trades in Europe just before the Industrial Revolution. Major trades, in addition to glass making, include: agriculture and rural arts; military arts; iron foundry and forge; extractive industries; metal working, masonry and carpentry; textiles; papermaking and printing; leather; gold, silver and jewelry; fashion; and miscellaneous operations such as soap making and canal building. (For a more complete review, see page 423, August, 1959.

Glastehnische Fabrikationsfehler, *by H. Jebsen-Marwedel* (2nd Edition, 1959; in German). Springer-Verlag, West Berlin, Germany. 800 figures; 2,000 references; $26.35 (Add 50 cents for postage).

When Jebsen-Marwedel published his first edition of his *Glastechnische Fabrikationsfehler* (1936) it soon became the leading book in this field with no competition in any other country. The book became a strong stimulant for those who wanted to contribute to a better knowledge of the technology of glass. A technology as old as that of glass with so many ramifications cannot be based on scientific progress alone but will always depend more or less on empirical discoveries.

It is the duty of scientists working in the field of glass to integrate the technological developments and the rapidly increasing scientific knowledge in high-temperature chemistry. This has been attempted successfully in the first edition and even more so in the present revised and greatly enlarged work. This successful combination of scientific thoughts and technical know-how is not accidental, however. In his subtitle the author sets it as a target when he calls his book: *A Pathology of the Material Glass as a Bridge from Science to Production.*

Combining the experience and the know-how of many years, the engineer can frequently remedy a situation intuitively by making certain changes. However, the laboratory of the glass plant should always follow up and examine all pertinent effects which these changes may have on the different properties of the glass. Progress in the glass industry depends a good deal upon the congenial cooperation between laboratory and production.

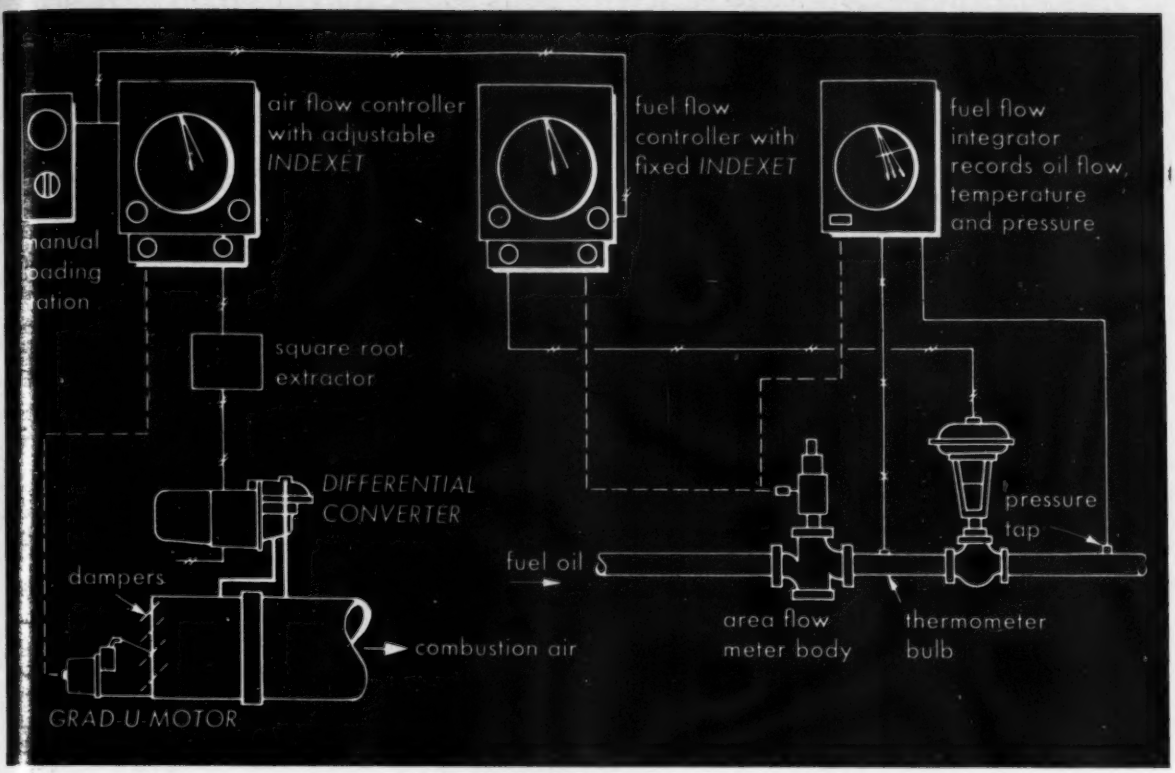
In order to accomplish this target, the author has greatly enlarged the volume and has included as many as 800 figures and 2000 well chosen references from the technical and scientific literature. Without sacrificing its unity and clarity, the author has succeeded in enlisting the cooperation of many of Germany's outstanding experts in different branches of glass technology. The book contains contributions of the following experts: Dr. K. Dinger, Direktor W. Giegerich, Dr. H. Hannes, Dipl.-Ing. K. Holler, Direktor Dipl.Ing. W. Lerch, Dr. J. Loffler, Dr. H. Petermoller, Dr. W. Prinz, Dr. L. Riedel.

The outline of the new book follows closely the first edition, and it is a logical one. First, the author makes us familiar with those defects, cords, blisters, stones, devitrifications and "off colors" which are characteristic for the glass melt proper. We learn the various sources which can be responsible for the occurrence of defects and their identification. The correct determination of the source of a defect requires often elaborate methods and it is particularly here where Jebsen-Marwedel draws on the experience of his colleagues. Every glass technologist will find very valuable information in these chapters; his search will be aided by the excellent photographs of the different defects.

To the researcher, however, the book provides a badly needed background of the physical chemistry of glass which is involved in its melting, fining, and shaping. Thus, the chapter on "cords" makes us familiar with the surface energies and with diffusion processes which partly prevent and partly help in the formation of a homogeneous glass. This chapter is particularly elaborate because Jebsen-Marwedel himself has contributed more to the understanding of the behavior of "glass in glass" than any other technologist.

The discussion of the various types of bubbles and blisters as well as that of the color of the glass introduces us into the complex interaction between the molten glass and the furnace atmosphere. Here we learn the physical chemistry of the melting and fining processes. It goes without saying that the experimental work discussed in this section is of significance for other technologies as well as for geochemistry. Minerologists and geochemists will be particularly interested in the chapters on devitrification and on the formation of crystals due to the interaction of glass and refractories.

After the discussion of those defects which are characteristic for the glass melt, the book turns to specific uses and shapes beginning with a chapter on blown and pressed ware followed by window and plate glass. Here, too, different defects require familiarity with certain fundamental properties of glass; e.g., its time-temperature-viscosity behavior for molding and its surface chemistry. These fundamentals are thoroughly discussed and well supported by references. The time-temperature-viscosity of the glass during molding depends upon the heat transfer through the mold as well as on radiation losses, the latter are strongly influenced by the color of the glass. Much emphasis is placed on the different defects which occur at the surface of glasses whether due



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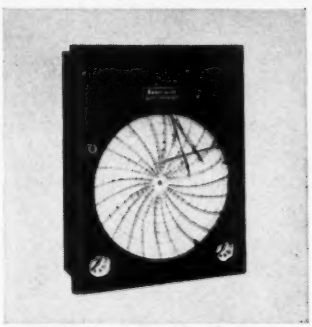

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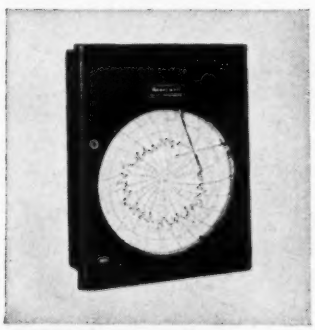

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to an improper molding temperature or to faulty grinding of flat glass.

The last chapters are devoted to the fractures of glass and glass cutting. Here we are introduced into the nature of "brittleness" and the different stresses and strains which occur in glass and their removal by annealing.

Throughout the book the author has found an admirable balance between technology and science, a balance which makes the book also suited as an advanced textbook of glass technology. Jebsen-Marwedel's book is a must on the bookshelf of every glass technologist.

The Effect of Radiation on Materials (Volume III, 1959). American Society for Testing Materials; 168 pages; $4.25.

The third and last in a series of volumes sponsored jointly by ASTM and the Atomic Industrial Forum. Divided into three parts, the first concerns dosimetry techniques; the second, radiation facilities and techniques; and the third, radiation effects.

While this book is primarily concerned with nuclear power and the design and construction of nuclear facilities, one chapter in particular should be of considerable interest to glass technologists: "Effects of High Neutron and Gamma Fluxes on Transmission Characteristics of Some Optical Glasses." Other chapters discuss the effects of radiation on various metals and alloys. All the information presented is based on new data.

Because of the rapid technological progress being made in this field, ASTM plans to continue this series and will sponsor a fourth symposium at the Third Pacific Area National Meeting in San Francisco, October, 1959.

Research Digest

(*Continued from page* 489)

was then charged into the previously described viscometer and equilibrated for 16 hours at 1204°C. before viscosity measurements were begun.

Viscosity-temperature relations of ER-348 were obtained over the temperature interval 1204°C. to 1482°C. in the manner previously described. Two viscosity-temperature curves were obtained, the one with increasing temperature initially being more viscous than the one with decreasing temperature. During a second heating and cooling cycle, the less viscous curve is followed, within the experimental error. The maximum difference between the two curves of 265 poises (32 per cent) is attained at 1200°C.

This cannot be the result of experimental error, as the maximum deviation in viscosity was ± 18 poises, and in temperature, ± 3°C. It likewise cannot be the result of volatilization, as the loss of volatile constituents should result in a more viscous, rather than a more fluid, melt. Chemical analysis of random samples of the glass before and after the viscosity determinations revealed that no constituent in the glass composition deviated more than ± 0.1 per cent during the course of the experiment. On the basis of the data obtained, it must be concluded that melting history can and does affect the viscosity-temperature relations of a glass melt.

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In terms of the concept of melting history, it is held that the less viscous curve represents the commonly determined and accepted viscosity, measured with glass melted in the high-temperature or conventional range. The more viscous curve might be construed as the true equilibrium viscosity. This is substantiated by the fact that the less viscous curve is equivalent, within experimental error, to that which is obtained when this glass composition is melted using standard laboratory procedures, and its viscosity measured with standard laboratory equipment. The interval through which the two viscosity curves are merged is indicative of the temperature range required for the degradation and reorganization process to occur at a rate of appreciable magnitude. Interpretation of these viscosity results in terms of the degradation and reorganization of structural units within the melt can explain this anomaly.

The glass melt, before obtaining the viscosity-temperature data, had not been heated above 1260°C., i.e., not more than 150°C. above its liquidus temperature. At this temperature very little degradation and reorganization of structural units should occur. The viscous flow unit initially should be a fairly large anionic structural grouping. As the temperature of the glass melt is increased, the degradation and reorganization of these anions produce a distribution of smaller units freely moving among large agglomerates.

Although this distribution of structural units is metastable as the temperature is decreased, the system is inhibited in its return to a thermodynamically stable configuration by kinetic considerations. The viscosity of the more fluid system might well increase if this glass were held for a sufficient length of time at 1204°C., thus closing the hysteresis loop.

In continuing with these melting history studies, some of the ER-348 cullet prepared in the manner previously described was charged into a small platinum resistance unit containing a single 0.080-in. orifice (called a one-hole bushing) and subjected to essentially the same melting history as was covered in the viscosity experiment. The melt was equilibrated at 1204°C. for 16 hours, and glass fibers were pulled at a constant pulling speed of 5000 ft. per minute. The temperature was gradually increased to 1482°C. in approximately one hour and then decreased to 1204°C. in an additional hour and fibers once again were pulled at 5000 ft. per minute. This heating schedule thus approximated that of the viscosity experiment. As an additional feature, the temperature was then increased to 1371°C., held for 16 additional hours, and lowered to 1204°C. and a third set of fibers was pulled at 5000 ft. per minute. At no time during this experiment was additional cullet added to the melting unit.

These three sets of fibers were then subjected to tensile strength measurements. From the results of this experiment it is apparent that a change in the tensile strength of the glass fibers has occurred as a result of the melting history. The strength of the fibers obtained from the melt which had not been taken to high temperatures has a frequency distribution indicative of a bimodal system. On the other hand, the strength of the fibers obtained from the melt after it had been taken to

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a high temperature yields a frequency typical of a Boltzmann distribution. Furthermore, it is to be noted that the peak strength values increase in the sequence of sets 1, 2, and 3.

It is evident that the previous melting history affects not only the physical properties of the melt but is a determining factor for certain properties in the vitreous state. The complex nature of the strength of glass makes any detailed interpretation of these data in terms of structure extremely difficult.

The structural model developed to account for the kinetics of the silicate melt-silica interaction has been applied to the general field of glass structure. It is held that a distribution of silicate structures is established at commercial glass-melting temperatures as a result of a degradation and reorganization process. Furthermore, it is proposed that this high-temperature structure is carried over, for the most part, into the vitreous state. Examination of this proposal has shown a possible means of reconciling the random-network model of Warren with the microheterogeneities more recently observed in the vitreous state.

The structural model also has led to the introduction of a new concept, "melting history," as a means of gaining a further understanding of glass properties. Viscosity and tensile strength measurements, in controlled experiments, have indicated the role of melting history in determining certain physical properties of glass. Extention of these experiments, which to date have been strictly exploratory, may clarify existing inconsistencies in the physical properties of glass through delineation of the respective roles played by melting history and by thermal history.

High-Temperature Alloys for the Glass Industry

(*Continued from page* 475)

example, the level of hydrogen gas in Viscotherm 5 is in the order of 0.000005 weight fraction; oxygen, in the order of 0.000010 weight fraction.

Out-gassing, due to the chemical reduction of constituents in the glass by metallic elements, is a function of the particular glass formulation, which is a vast study in itself and can only be mentioned here.

Table II
CONDITIONS OF MOUNTING SEVERITY IN PARTS FOR THE GLASS INDUSTRY

	Thermal Cycling	Stressed	Dynamically Loaded
Fig. 2 blow tip	Yes	Some	No
Fig. 5 nozzle	No	No	No
Fig. 6 pin	Yes	Yes	Yes

Summary

Table II shows the several conditions of mounting severity in glass applications and combinations thereof as shown by the parts described in the foregoing figures.

CONCLUSION

As performance data is built up on the Viscotherm alloys it is felt that they will move further back in the glass furnace. At present, being used experimentally in the forehearths and refiners, these alloys will find greater application in the melters themselves.

(Next month, in the concluding article, the author will describe in detail the vacuum induction melting process by which Viscotherm alloys are produced.)

Nickel and Cobalt Films

(*Continued from page* 477)

This solution may be used at room temperature, or hot. Its shelf life is ideal for at least 25 days. After the surface has been treated with this solution, it is rinsed with running water.

Pearlstein made a detailed study of tin chloride sensitizers with a view to determining the minimum concentration which could be employed. His preliminary sensitizer contained 100 grams tin chloride and 50 cc. hydrochloric acid per liter of water. The following procedure was used to obtain the data in Table 1.

1. Dip the object for 1 minute in various concentrations of tin chloride solution at 80°F.
2. Rinse under running water.
3. Dip for 1 minute in a solution of 0.1 gram palladium chloride per liter of water. The pH will be 1.7. The temperature of the solution should be 80°F.
4. Rinse under running water
5. Dip for 1 minute in electroless nickel solution at 200°F.

Table 1
EFFECT OF TIN CHLORIDE AND ACID

Composition of $SnCl_2$ solution	Per cent of Area Coated With Nickel
100 g/1 + 50 cc. HCl	100
20 g/1 + 10 cc. HCl	100
4 g/1 + 2 cc. HCl	100
0.8 g/1 + 0.4 cc. HCl	100
0.16 g/1 + 0.8 cc. HCl	100
0.032 g/1 + 0.016 cc. HCl	20

A small quantity of wetting agent was added to the foregoing soluting solution, with beneficial effects.

Dr. Narcus claims that his version of the sensitizer "gave improved results with regard to more rapid coverage and adhesion of the electroless nickel than the previous" tin chloride-hydrochloric acid solutions in any of their forms: His solution consisted of:

Stannous fluoborate conc. (47%)	15-20 grams
Fluoboric acid (42%)	50 cc.
Hydrofluoric acid (52%)	10 cc.
Triton NE (1% by Weight)	10 cc.
Water	1000 cc.

This solution is operated at room temperature, the immersion time being 2 minutes. The solution is best kept in rubber or a polystyrene container.

This sensitizing treatment is followed by a thorough cold-water rinse and then a warm-water rinse. This insures removal of residual salts, an important factor in certain electronic applications. Any drag-in of the sensitzing solution into the activator next used in the process, is also prevented.

Dr. Brenner in reporting his efforts with sensitizing glass or plastic surfaces, states that a solution of hydrazine may be used in place of tin chloride, and presumably

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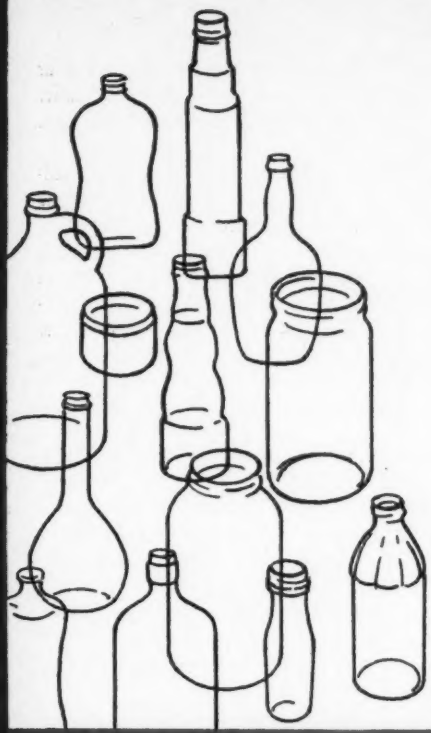
have made



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other reducing agents can be used as well. He further states that in some instances a suitable wetting agent in the reducing solution improved the results.

Super-Sensitizing

The purpose of this phase of the process is to serve as a means for "activating" or "seeding" out the metallic nickel or cobalt. In principle, super-sensitizers act as a catalyst.

The noble metals, such as silver, gold, platinum, irridium, and palladium are usually used in aqeous solutions with or without a suitable mineral acid.

The most commonly used activating or super-sensitizer solution to produce a catalytic surface for formation of electroless nickel coatings is palladium chloride in varying concentrations and at values of pH and temperature.

The use of gold chloride is described by Wein as early as 1924. Narcus recommends:

Gold chloride (50%)	0.01—0.1 gram
Water	1000 cc.

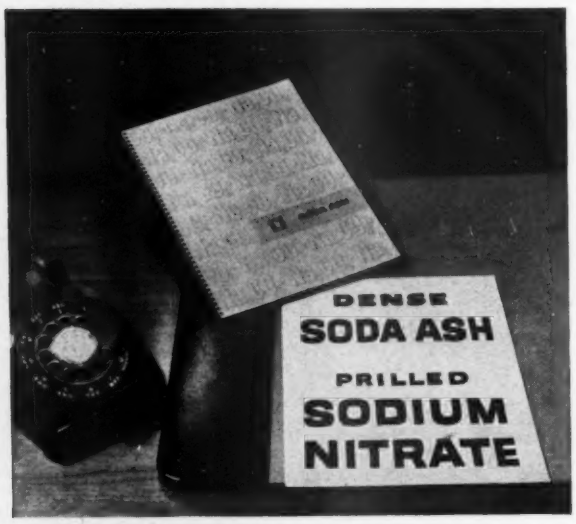
The solution is operated at room temperature with a two-minute immersion time.

The cost of commercial gold chloride (50 per cent metal) is comparable to that of palladium chloride. However, gold chloride is more soluble in cold water than palladium chloride. The latter requires hydrochloric acid to give it a clear operating solution, while gold chloride can be operated with or without the addition of hydrochloric acid. If the acid is preferred, only 1 cc. need be added per liter of solution.

If palladium chloride solution is operated without hydrochloric acid, it is necessary to stir the bath thoroughly prior to its use in order to insure best catalyzation of the surface. Furthermore, the palladium chloride solution is most effective in hot solutions for longest solution life. These hot solutions are more susceptible to decomposition or less bath life. Palladium chloride also causes a more spontaneous decomposition of the electroless nickel bath if any enters that processing bath. Even though the surface to be coated is thoroughly rinsed in both cold and warm water after treatment in the activator, there still seems to be spontaneous decomposition of the nickel bath—so called "black precipitate formation"—which causes depletion of the nickel solution. A separate electroless nickel strike solution is usually necessary prior to the main bath when a palladium chloride treatment is employed. Conversion of the palladium chloride film to metallic palladium is a step in the right direction but when parts are processed in bulk there is much to be desired.

On the other hand, gold chloride activation gives fewer decomposition products if some of the solution enters the electroless nickel bath. Fortunately, an aqueous solution of gold chloride, such as the one described, rinses more easily, especially if both a cold- and a warm-water rinse is used after activation treatment. Hence, the life of the nickel bath is much longer.

A cleaning procedure was adopted by Pearlstein so that the polystyrene surface would be in a uniform condition before applying experimental tests. Cleaning with



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steel wool and foaming cleanser produced a clean, slightly roughened surface which, however, did not completely wet with water. A 30-second dip in a chromic-sulphuric acid cleaning solution was found effective for producing a water-break, free surface after the steel wool and cleanser treatment.

In all cases, the films formed by immersion of non-metallic materials in $PdCl_2$ solutions were invisible. The presence of an activating film was ascertained by its ability to initiate nickel deposition from the electroless nickel solution. The effectiveness of the treatment was determined by the estimated percentage of the area which was found to have been coated with nickel.

Polystyrene panels were rinsed for two minutes in 0.1 gram per liter of $PdCl_2$ solutions of varying pH and temperature, rinsed, and submerged in the electroless nickel solution. The results are shown in Table 2.

Table 2
EFFECT OF pH AND TEMPERATURE
Per cent of Area Coated With Nickel

pH of $PdCl_2$ solution	80°F.	110°F.	125°F.	165°F.
3.0	0	0	2	10
3.4	0	15	25	100
3.8	0	99	100	100
4.4	40	99	100	100
4.8	90	100	100	100
5.8	0	2	5	.....

As can be seen from Table 2, an increase in the temperature of the $PdCl_2$ solution increases the permissible pH range which can be satisfactorily employed.

Table 3 shows the effect of pH when using a 0.01 gram per liter solution of $PdCl_2$. The permissible pH range of the $PdCl_2$ solution is decreased when the $PdCl_2$ concentration is decreased.

Table 3
EFFECT OF PALLADIUM CONCENTRATION

pH of $PdCl_2$ solution	Per cent of Area Coated With Nickel
1.0	0
3.0	70
4.1	100
6.4	0

The next step was to study how much a stock solution of 0.50 gram per liter of $PdCl_2$ (to which 5 cc. per liter of hydrochloric acid had been added) could be diluted before the effectiveness of the solution was affected.

In order to ascertain the effectiveness of the palladium chloride solution, a piece of polystyrene (plastic) was first immersed in a solution of palladium chloride—0.1 gram per liter (pH 1.7)—for 20 hours; it was rinsed, then plated with nickel from an electroless nickel solution.

The results were negative; however, when a roughened panel was immersed in the same $PdCl_2$ solution and placed in the electroless nickel bath without rinsing, most of the area was soon found to be coated with nickel. Apparently, the reducing environment of the electroless nickel bath caused reduction of the $PdCl_2$ solution adhering to the plastic. This method rarely produced

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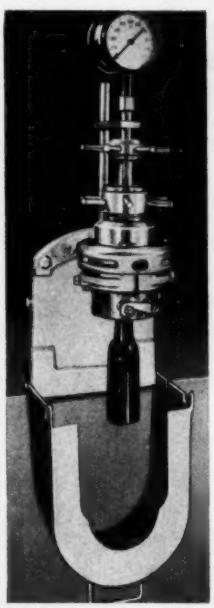

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complete coverage of nickel, and excess $PdCl_2$ entering into the electroless nickel bath resulted in its premature decomposition.

Roughened polystyrene was then placed in the $PdCl_2$ solution at about 190° F. for about 15 minutes and thoroughly rinsed. When placed into the electroless nickel solution, portions of the surface were found to have been activated and were coated with nickel. Presumably $PdCl_2$ was caused to be adsorbed upon the surface; whereupon immersion in electroless nickel solution resulted in reduction of palladium to form an active surface for electroless nickel deposition.

The following procedure was used to obtain the data in Table 4:

1. Dip 1 minute in the following sensitizer solution at 80°F.

Tin chloride	70 grams
Hydrochloric acid	33 cc.
Water	1 liter

2. Rinse under running water.
3. Dip 1 minute in various concentration of $PdCl_2$ solution at 80°F.
4. Rinse under running water.
5. Dip 1 minute in electroless nickel solution at 200°F.

Table 4
EFFECT OF PALLADIUM AND ACID

Composition of $PdCl_2$ solution	Per cent of Area Coated With Nickel
0.5 g/1 + 5 cc. HCl	100
0.1 g/1 + 1 cc. HCl	100
0.02 g/1 + 0.02 cc. HCl	100
0.004 g/1 + 0.04 cc. HCl	10

When the solution containing 0.004 grams per liter of $PdCl_2$ plus 0.04 cc. hydrochloric acid was used at a temperature of about 180° F. the polystyrene was completely coated with nickel.

In order to test the ability of materials other than polystyrene to be activated by $PdCl_2$ solution, the techniques outlined above were applied to the following materials: Plexiglas, Polystyrene, Mylar, Cellulose acetate, Cellulose nitrate, Nylon, Glass, Saran, Teflon, Mycalex, a fragment from a porous aluminum oxide grinding wheel, and Textolite. The materials were roughened and cleaned before applying the activating treatments, and the following procedures were used:

A

1. Dip 2 minutes in 0.1 gram per liter of $PdCl_2$ (pH4.5) at 160°F.
2. Rinse under running water.
3. Dip 1 minute in electroless nickel solution at 200°F.

B

1. Dip 1 minute in 70 grams tin chloride per liter containing 40 cc. HCl at 80°F.
2. Rinse under running water.
3. Dip 1 minute in 0.1 gram per liter of $PdCl_2$ containing 1 cc. HCl at 80°F.
4. Rinse under running water.
5. Dip 1 minute in electroless nickel solution at 200°F.

The results are shown in Table 5.

Difficulty was encountered in completely coating some of the materials listed in Table 5 because of incomplete wetting by the solutions. Proper choice of wetting agents may rectify this situation.

It must be remembered that the procedures described above were developed for coating polystyrene. Modifications of solutions and techniques may be necessary depending upon the characteristics of the particular material to be coated.

Table 5
RESULTS ON MISCELLANEOUS MATERIALS

Material	Per cent of Area Coated With Nickel "A"	Per cent of Area Coated With Nickel "B"
Polystyrene	100	100
Plexiglas	60	100
Polyethylene	30	90
Mylar	100	100
Cellulose acetate	95	100
Cellulose nitrate	10	100
Nylon	100	100
Glass	1	100
Saran	99	100
Teflon	10	80
Mycalex	0	0
Alundum	80	100
Textolite	100	100

(*To be continued*)

Russian Translations

(*Continued from page* 479)

Another two refractories were similarly tested in a molten borosilicate glass ZS-5. The results are shown in Table II.

TABLE II

Refractory composition, Per cent			Loss in Thickness, mm./24 Hour	
			Below Level of Molten Glass	At Level of Molten Glass
Al_2O_3	SiO_2	ZrO_2		
52	16	32	1.44	0.17
64	14	22	1.20	0.19

As the best refractory contains too much zirconia, it cannot be prepared from the mineral zircon available in U.S.S.R. and needs baddeleite which is imported from Brazil. Consequently the 54: 16: 30 material and near refractories (called "Ziralite") are recommended.

Testing the roughness of ground glass

G. M. Gorodinskii, A. G. Minakov and R. I. Tsoi describe, in *Steklo i Keramika* (Glass and Ceramics) *13*, No. 12, p. 9 (1956), a test of the surface roughness of ground glass, carried out directly on the grinding table.

The degree of roughness is computed from the intensity of light specularly reflected by the ground surface. A handy instrument for measuring this intensity is available. The instrument is calibrated in terms of the average height H of surface asperities by applying it to several surfaces whose H has been determined by another procedure. The determination of the H of a glass sheet in 5 areas of 10 square centimeters each requires 10 minutes if 2 operators perform it.

The usual ground glass sent for polishing has H of 2.5-2.7 microns. If H is greater than 4.5 microns, the sheet must be ground anew.

Ground quartz in borosilicate batches.

The acceleration of glass formation achieved by using sand ground in a ball mill is described by M. A. Matveev, I. S. Koifman and L. A. Grechanik in *Steklo i Keramika* (Glass and Ceramics) *13*, No. 11, p. 3 (1956).

High quality quartz sand was ground in a ball mill (the charge was 65 kilograms) containing 220 kilograms

Porter Zircon Pavers for Glass Tank Bottoms

Torture test proves Porter Zircon Paver

This unretouched photograph shows comparison of Porter PZ Zircon and another commercially made Zircon Paver, after an extensive glass corrosion test. The sketch and photograph illustrate a 6″ diameter crucible with two semi-circular test pieces 1″ thick, cut and cemented with Zircon Cement to form a paved bottom. Crucible was held at 2680°F for 24 hours, filled with molten soda-lime container glass. Crucible was then cut in half across center of both test pieces to show comparison. Crucible partly immersed in liquid of same refractive index as glass to eliminate effects of saw marks and fracturing of glass and to give clear view of glass directly above and in contact with test pieces.

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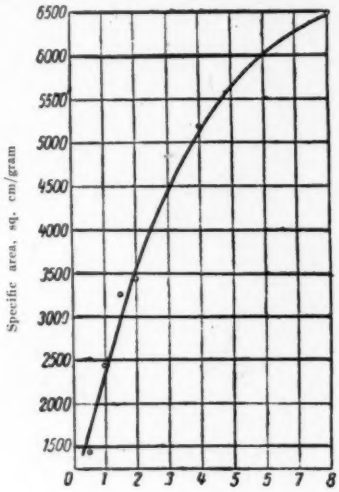
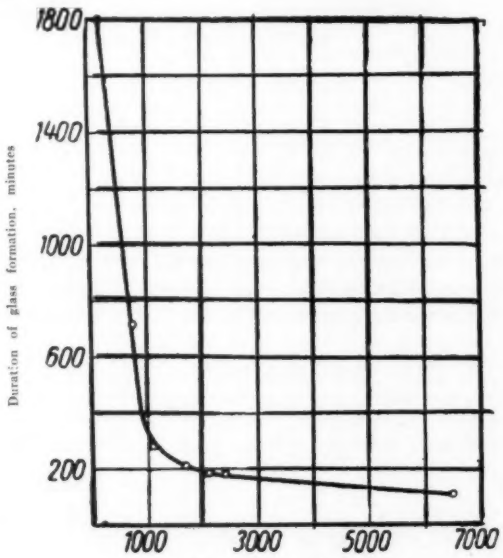
of porcelain balls. Figure 1 shows the increase of the specific area of the sand with time. As the balls were abraded during the grinding, the amount of alumina in the sand gradually increased and reached for instance about 1.5 per cent after 2 hours of grinding. In later experiments glass balls were employed. The mill had to be rubber-lined inside as otherwise so much iron was



Duration of grinding hours
Fig. 1

abraded that the resulting glass contained 0.13 per cent Fe_2O_3.

The sand had to be dry when introduced in the mill: the specific area after 1 hour of grinding was 2420 sq cm./gram when the moisture content of the sand was 0.02 per cent and 780 sq. cm./gram when this was 5.6 per cent. Before emptying the mill, the sand was moistened to avoid dust formation.



Specific area, sq. cm./gm.
Fig. 2

When sands of different specific areas were used for making borosilicate glass ZS-5 (composition not given) in a platinum crucible at 1350°C, the duration of the glass

formation was shorter the greater the specific area. This is illustrated by Fig. 2.

Since the effect of increasing the specific area above 2000 sq. cm./gram was small, the grinding was carried out for one hour in the following experiments. These experiments were performed in 100-kilogram pots and finally in periodic function furnaces of 2500 kilograms capacity. The time needed for glass formation was reduced in the ratio 2:3 by using ground sand, but the time needed for fining naturally was not altered. Thus the total time a charge spent in a furnace was shortened from 24 hours to 21-22 hours only. However, the resulting glass contained fewer defects than the glass made from the coarse sand. The increase in income caused by the higher percentage of acceptable production was 10 times as great as the expense of ball mill grinding.

Fifth International Glass Congress

(*Continued from page* 472)

of the appearance of a new (10.5) band with high PbO, and of 14.0 band with Al_2O_3 in these glasses, although presented in session VI[40] also should be reported here.

The remainder of session VII was devoted to heat transfer. PILKINGTON Laboratories[41] extended the work of CZERNY'S school to the non-steady state. The order of magnitude of the results was as expected, but more knowledge of the dependence of ordinary conductivity with temperature would be needed. SCHOTT Laboratories[42] presented calculations of radiation conductivity for the case of cylindrical symmetry.

Acoustical and Optical Beauty were in the environment that our hosts had selected with equal taste and care. This reviewer was fascinated by sound and vision during a candlelight concert, in Nymphenburg castle, with a distinguished orchestra, a youthful and genial violin soloist in a delightful sequence of Mozart and Beethoven.

The traditional Wednesday off was spent in the Bavarian Alps where intelligent anticipation defeated the destructive force of a rainy day by opening to us the rokoko delicacies of the Wieskirche, that is the Church of Wies town, a gem that was the choice result of diligent and erudite scouting by the Secretary of the German Glass Society, Dr. Guenther. To him go praises for a thorough and thoughtful Congress plan, on and off the beat, and to his charming wife for her silent help to him and her gracious presence that lent subtle assistance everywhere.

At the dance, opened by a waltz competently danced by the President of the Congress, Herr von Buelow and his lady, the true representatives of the best of Germany's hospitality, Bavarian girls in Bavarian style gave souvenirs, while the State Opera Ballet performed. Folk dance groups adorned the night of the Alpine trip. The Congress was guest, also, at the opening of the German Museum's new Glass Exhibit by the authorities.

Little Summit

Russian and American scientists continued a tradition established on a Seine boat in Paris in 1956 and convened with caviar and vodka (in measure) and glass

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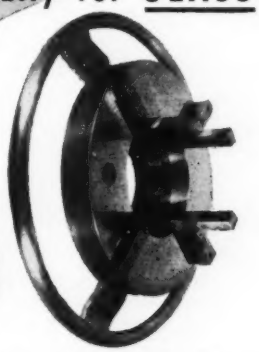

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structure (in plenty) some noon in Munich's Drei Löwen. No introduction was needed as still was in Paris to start shop talk galore. Russia's Mrs. M. Aslanova, Director, Fiber Glass Institute; A. Appen, Institute Silicate Chemistry; Dr. Lomteving, Gosplan RSFSR; V. Vargin, Institute Silicate Technology and Dr. V. Dubrovsky, Glass Institute traded ideas with America's W. A. Weyl, Penn State; A. B. Bestul, NBS; B. L. Steierman, Owens-Illinois; A. J. Cohen, Mellon Institute and N. Kreidl, Bausch & Lomb. There was manifest a genuine interest in Russian participation in two coming U. S. affairs, the Gordon Conference of 1960, and the Congress of 1962.

Erhard and the Common Market

The spirit that created this meeting, under the guidance of Guenther and von Buelow, and the countless glass men and women whose enthusiasm must have been behind its success, also gave us a political event of no little significance in the form of an address to the Congress by Dr. Erhard, minister of the German Federal Republic, and able protagonist within the Christian Democratic Party of Mr. Adenauer. Erasing the impression which the photographs of this massive man may create, thought, style and delivery evolved spontaneously in an excellency seldom encountered.

Spontaneous is hardly the word to describe how Erhard creates not only the idea, but the style of each sentence as he goes on. An example of this care is his use of the term "development nations" where we are used to "underdeveloped nations."

Since this is not the political press—which, incidentally, took notice of this glass talk as ours would of a major address from a Vice President—it will suffice to state what seemed to be Erhard's major point. The establishment in Europe of the Common Market, he said, would be the failure rather than the accomplishment of his life, were it but a goal in the unprecedented lift it has given its members. No, it must be a nucleus for broader understanding and economic cooperation.

He had blueprints for this he assured us, certainly with an eye on his strife for power—but he also felt that there was a built-in mechanism for such expansion in the interest each member had to continue favorable exchanges with particular non-members in particular fields of trade. He congratulated glass men who have, in their sphere, established such cooperation in the organization and spirit of the Munich Congress.

—N. J. Kreidl

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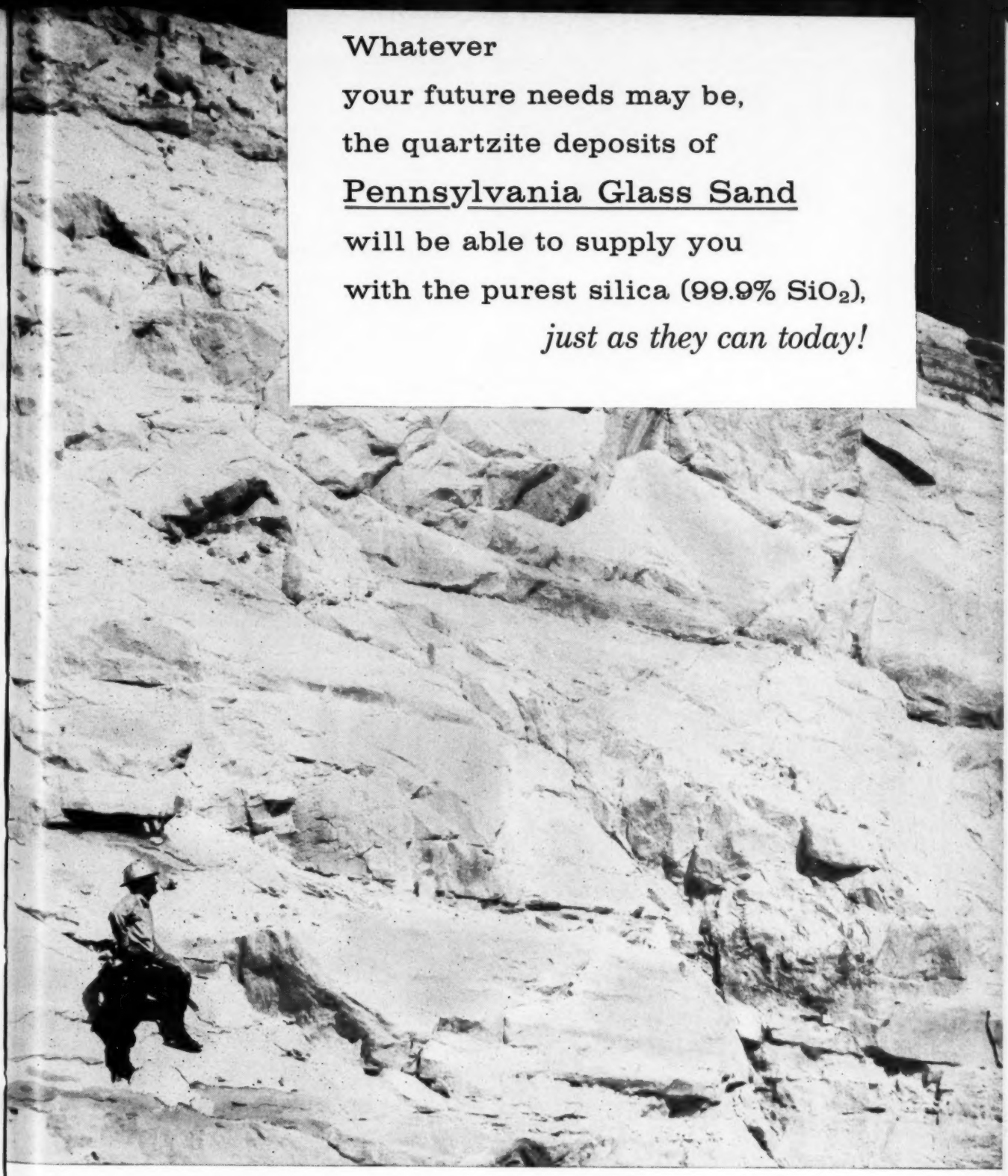
Inventions and Inventors

(*Continued from page* 487)

The invention has an object to mount a rotating member, such as a rotating agitator, or a rotating electrode, or a rotating member which is both an agitator and an electrode, in the wall of a furnace for treating glass or analogous materials. This mounting comprises a graphite sleeve which penetrates through at least a part of the thickness of the furnace wall and serves as a bearing for the rotating member.

The rotating member may be composed wholly of graphite, and in such case it is mounted in the bearing with a bearing fit or with only such tolerance as is permitted in bearing practice. On the other hand, when the rotating member is metal, or other refractory material than graphite, the part of the rotating piece which engages the encircling bearing should be provided with a graphite sleeve which fits snugly over it and to the graphite bearing.

In the preferred form of the invention, the bearing sleeve which is mounted in the wall of the furnace is encircled by a cooling device, such as a water jacket, which also extends, at least partly, into the wall. It has



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The plunger shown, mate to the Colmonoy-protected thimble, has been hard-surfaced with Colmonoy No. 4 also. The Colmonoy Spraywelder, a powder metal spraying unit, was used to produce the sprayed-and-fused overlay. The two parts, with similar long wearing surfaces, provide the ultimate in wear resistance.

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been demonstrated that under these conditions the bearing sleeve in the wall and bearing surface of the electrode form a tight joint through which the glass will not escape, and that it is unnecessary to employ a molten metal to seal the joint between the two pieces.

There were 21 claims and 12 references cited in this patent.

Glass Compositions

Glass composition. Patent No. 2,877,124. Filed November 25, 1955. Issued March 10, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by William W. Welsch.

Certain fiber forming processes use centrifugal force for delivering bodies of glass into an angularly shaped gaseous blast which attenuates the glass into very fine fibers.

The glass should have a low liquidus temperature, a wide range of temperatures at which the glass can be attentuated and a slow rate of devitrification.

It is an object of the invention to provide glass compositions having a relatively low cost and containing no ingredients which produce noxious fumes when the glass composition is melted. It has been discovered that a glass composition comprising silica and certain other glass forming ingredients which remains substantially free of fluorine or other like elements or compounds comprises the following ingredients expressed in weight percent:

Ingredients	Proportion
SiO_2	50 to 65
Al_2O_3	0 to 8
CaO	3 to 14
MgO	0 to 10
Na_2O, K_2O, Li_2O	10 to 20
B_2O_3	5 to 15
TiO_2	0 to 8
ZrO_2	0 to 8
BaO	0 to 8
Fe_2O_3	0 to 12
MnO	0 to 12
ZnO	0 to 2

There were 10 claims and the following references cited in this patent.

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Glass Wool and Fiber

Apparatus for melting and fiberizing refractory materials. Patent No. 2,823,416. Filed August 16, 1955. Issued February 18, 1958. No sheets of drawings; none reproduced. Assigned to Johns-Manville Corporation, by Edward R. Powell.

The invention relates to an apparatus for converting a molten raw material into fibers, the apparatus being

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particularly adapted for melting and fiberizing in-organic refractory materials.

In operation, a fused bath of material forms around the electrodes which are arranged to penetrate the bath as in conventional resistance heating. The refractory material adjacent the walls of shell does not fuse and acts to protect the walls against the extreme heat of the bath. The molten material flows from the primary melting zone around large electrodes toward the secondary forehearth zone with which the primary zone communicates. The purpose of the forehearth zone is to maintain the melt at a high enough temperature at the region adjacent pouring lip so that a continuous stream having the proper fluidity may be fed to the fiberizing unit.

Positioned beneath the outer end of the trough is a fiberizing means schematically shown as a multi-rotor apparatus of the type given in U. S. Patent to Powell No. 2,520,168. Conventionally, rotor fiberizing apparatus is mounted on a support means which is pivotable about a vertical axis whereby the apparatus may be swung into and out of position beneath pouring trough.

There were 2 claims and the following references cited in this patent.

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704,600, Great Britain, Feb. 24, 1954 and 1,069,730, France, Feb. 17, 1954.

Sheet and Plate Glass

Electrically conducting glass. Patent No. 2,833,902. Filed October 30, 1953. Issued May 6, 1958. No sheets of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by Romey A. Gaiser and Lazarus D. Thomas.

The invention relates broadly to electrically conducting glass of the type made up of a sheet of glass having a transparent electrically conducting film of tin oxide, in contact with metal electrodes, on the surface.

It is an important aim of the present invention to provide an electrically conducting glass unit of the general character above described but which exhibits a relatively strong and low resistance interface between the metal electrode and the stannic oxide film, and which overcomes the difficulties heretofore encountered in such units without the necessity for extra process steps in addition to those of film and electrode application, or for the introduction of additional elements to connect or overlie the film and electrodes.

Such a unit is accomplished if a leading spray of the organic chloride ion-free material is used, followed by one or more sprays of the conventional stannic chloride solution, a film is produced which has all of the good electrical and optical properties of the stannic chloride produced tin oxide film without the objectionable high resistance band at the silver electrode-stannic oxide film interface.

In practicing this latter phase of the invention, the

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right or left hand set of guns can be used as the lead guns, depending on the direction in which the carriage is moving. It should also be noted that the vapors of both dibutyl tin diacetate and dibutyl tin diformate, two of the preferred halogen-free, organic tin compounds, are extremely disagreeable and possibly toxic which necessitates the installation of adequate ventilating facilities in the filming set-up.

Electrodes of sprayed copper, sprayed copper alloys, gold, silver and platinum fluxes and combinations of these materials have all been used satisfactorily.

There were 8 claims and the following reference cited in this patent.

United States Patents

2,628,299, Gaiser, Feb. 10, 1953.

Tube and Cane Machines

Apparatus for reshaping cylindrical glass tubes. Patent No. 2,862,335. Filed June 12, 1957. Issued December 2, 1958. No sheets of drawings; none reproduced. Assigned to General Electric Company by Bernard Shaw, John Salo, and Paul Barclay.

The present invention relates to apparatus for reshaping hollow glass bodies and more particularly the invention relates to apparatus for reshaping elongated cylindrical glass tubes used as envelopes for evacuated electric discharge devices, such as double-ended tubular fluorescent discharge lamps.

An important feature of the apparatus embodying the invention is a heated press bed or mold for supporting in a horizontal position the open-ended tubular glass envelope or blank to be reshaped. The mold conforms in shape to the lower half of the blank and is mounted for movement on the apparatus into a first position in which the heated mold accepts a preheated glass blank, a second position in which the selected portions of the blank to be reshaped are heated to the temperature at which the glass at the portions become plastic and thence to a third position in which the plastic portions of the blank are reshaped and the blank thereafter removed from the mold. The mold is movable directly from its third position to its first position on the apparatus after removal of the reshaped blank therefrom to accept and carry a succeeding preheated blank to the second and then the third positions of the mold.

Another feature of the apparatus is a preheat mechanism for the glass blank which heats the entire blank to a temperature slightly below the softening temperature of the glass and delivers the blank so heated to the mold when the latter is moved from its third into its first position.

A further feature of the apparatus is an elongated segmented burner mounted in a horizontal position on the apparatus and above the space occupied by the mold in its second position.

There were 7 claims and the following references cited in this patent.

United States Patents

1,489,836, King, Apr. 8, 1924; 2,482,421, Lemmers, Sept. 20, 1949; 2,523,006, Gaskill et al., Sept. 19, 1950, and 2,529,678, Casselle, Nov. 14, 1950.

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